TM 5-632

WAR DEPARTMENT TECHNICAL MANUAL

INSECT AND RODENT CONTROL

REPAIRS AND UTILITIES

WAR DEPARTMENT · *OCTOBER 1945*

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United States Government Printing Office
Washington : 1945

WAR DEPARTMENT
WASHINGTON 25, D. C., 16 October 1945

TM 5–632, Insect and Rodent Control, is published for the information and guidance of all concerned.

[AG 300.7 (4 Oct 45)]

BY ORDER OF THE SECRETARY OF WAR:

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Refer to FM 21–6 for explanation of distribution formula.

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CHAPTER 1
INTRODUCTION

1. Purpose and Scope

This manual discusses insect and rodent pests and their control at Army installations. Special emphasis is placed on the work of the Corps of Engineers in carrying out the measures recommended by the Medical Department to control pests affecting the health and morale of Army personnel. Procedures for controlling pests attacking Army property and supplies are also described. The text includes water management and larviciding for mosquito control; ratproofing and termiteproofing of buildings and structures; area control of such pests as ants, chiggers, flies, and Japanese beetles; and fumigation of supplies. Information printed herein is based on a large number of publications prepared by public and private agencies; additional information on any particular phase of insect and rodent control can be obtained from these sources, listed by chapter topics as references in appendix II.

2. Importance of Control

Insect and rodent control is essential in combating disease, preventing property loss, and maintaining troop morale. Loss of life or man-hours caused by insect-borne diseases such as malaria, filiariasis, dengue, encephalitis, plague, typhus, Rocky Mountain spotted fever, tularemia, dysentery, cholera, and typhoid fever make insect control imperative. Although measures now practiced have reduced manpower loss from these diseases to the lowest point in Army history, only a continuing control program can successfully cope with the problem. Also, if insects and rodents are not controlled, great losses to the Army result from damage to clothing, subsistence, and many items of property. Rats, roaches, moths, and various beetles attack stored products; termites can cause extensive and rapid deterioration of wood structures at many installations.

3. Responsibility

Responsibility for insect and rodent control at Army installations rests with the Medical Department and the Corps of Engineers. The Quartermaster Corps furnishes supplies other than engineer and medical items.

a. Medical Department. The Medical Department is responsible for investigating sanitary conditions and making recommendations for any necessary corrective action (AR 40–205); this responsibility includes recommendations for the elimination of rodents, vermin, and disease-bearing insects. It is also responsible for initiating and supervising measures for the control and prevention of disease in military personnel. (See AR 40–210.)

b. Corps of Engineers. The Corps of Engineers is responsible for the execution of insect and rodent control measures necessary for protection of health and morale and for preserving Army property (AR 100–80), in accordance with recommendations and any necessary technical supervision by the Medical Department.

(1) *Buildings.* For post buildings, this work frequently involves screening, protection from termite damage, ratproofing, and fumigation.

(2) *Grounds.* (*a*) *Water.* Elimination of excess run-off water and control of natural drainage to avoid potential breeding places for mosquitoes are included.

(*b*) *Soil.* Aerating soil, ridding grounds of wet areas where flies may breed, disposal of waste, and filling in ground depressions are engineering problems in pest control.

(*c*) *Vegetation.* The cutting and burning of brush, spraying of vegetation, and similar activities are examples of Corps of Engineers work.

(*d*) *Equipment.* Commercial procurement or design and construction of such equipment as insecticide sprayers, dusters, and flytraps are typical engineer functions. Installing of necessary equipment used in the control program, such as fumigation chambers used for insect control, is included.

4. Need for Cooperation

a. Medical Department. Teamwork between the Medical Department and the Corps of En-

gineers is necessary to insure that pest-control organization functions effectively at all levels.

(1) Surgeon General's Office and Office, Chief of Engineers.

(2) Service command surgeon and service command engineer.

(3) Post surgeon and post engineer.

b. Quartermaster Corps. The Quartermaster Corps collaborates with the Medical Department and the Corps of Engineers in procuring equipment and supplies.

c. Public Health Service. The Corps of Engineers cooperates with the Public Health Service in control work on areas adjacent to Army reservations, particularly in the control of species of insects and rodents which either may affect troop health and morale or jeopardize Army property.

d. Navy Department. Close contact between the insect and rodent control work of the Army and Navy is maintained by exchange of information, joint participation in control programs, and exchange of equipment and apparatus whenever desirable.

e. Department of Agriculture. Expert assistance and information regarding the control of insects is obtained by the Corps of Engineers from the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture.

f. Department of Interior. The Bureau of Fish and Wildlife Service, Department of Interior, is another source of information and assistance. Specialists in the control of rats, mice, ground squirrels, gophers, and other pests cooperate with service commands.

CHAPTER 2
MOSQUITOES

Section I. GENERAL

5. Need for Control

Mosquito control is of vital importance to the Army because mosquitoes carry disease and may impair personnel efficiency.

a. Disease Transmission (fig. 1). Malaria, dengue, yellow fever, filariasis, and equine encephalitis are known to be mosquito-borne. Other diseases are also believed to be spread in this manner.

(1) Malaria is one of the most disabling diseases confronting the Army, causing some fatalities and seriously affecting the health of a great number of survivors. The disease is general throughout tropical and subtropical regions and prevalent in the southeastern States. Malaria is transmitted entirely by mosquitoes of the genus *Anopheles*.

(2) Dengue is an acute infectious disease with a negligible mortality rate, occurring in many tropical and subtropical regions. Epidemics have occurred in the Gulf States region. Dengue is transmitted by mosquitoes of the genus *Aedes*.

(3) Yellow fever is confined to South America and Africa, but mosquitoes capable of transmitting this disease are present throughout the southern United States.

(4) Filariasis is distributed worldwide within the tropical and subtropical belts. Mosquitoes with wide distribution in the United States and other countries transmit this disease.

(5) Equine encephalitis, found chiefly in the northern half of the United States, is carried by mosquitoes of the genera *Aedes* and *Culex*. It is sometimes carried from animals to man.

b. Mosquitoes as Pests. Comfort, efficiency, and morale of troops are often lowered by mosquito pests. The house mosquito (*Culex spp*) feeds on man only at night; other types attack him in daytime.

6. Control Methods and Responsibility

Mosquitoes lay their eggs either on the surface of water or on ground subject to flooding. Larvae hatch from these eggs and feed upon organic matter in the water. Since development of mosquito populations depends upon water for the growth of the early stages, control involves the treating of breeding places to make them unfit for mosquito development. The Medical Department is responsible for identifying species of mosquitoes, conducting surveys, recommending control measures, and providing the necessary technical supervision of the work. The Corps of Engineers carries out the control measures recommended.

Section II. PERMANENT CONTROL METHODS

7. General

Posts to be occupied for several months or longer need permanent methods of mosquito control, generally achieved by eliminating or controlling the breeding waters. Since stream ditching, pumping, and filling are involved, these procedures require considerable time, labor, and equipment. (See figs. 2 and 3.) The high initial costs are justified only if they are less than the expense of applying temporary measures during the post's occupancy. No permanent program is recommended by the Medical Department until careful surveys and plans have been made by experienced personnel.

8. Camp Site Selection

Mosquito control should be one of the factors considered in selecting a camp site. Locations requiring a long period to effect control, or costly ditching, filling, and other methods of water-surface control, should be avoided. Sites should be farther than the flight distance of adult mosquitoes (1 to 2 miles for anophelines) from the following:

a. Extensive breeding places. (See fig. 4.)

PRINCIPAL CHARACTERS FOR IDENTIFYING THE THREE GENERA OF MEDICAL IMPORTANCE

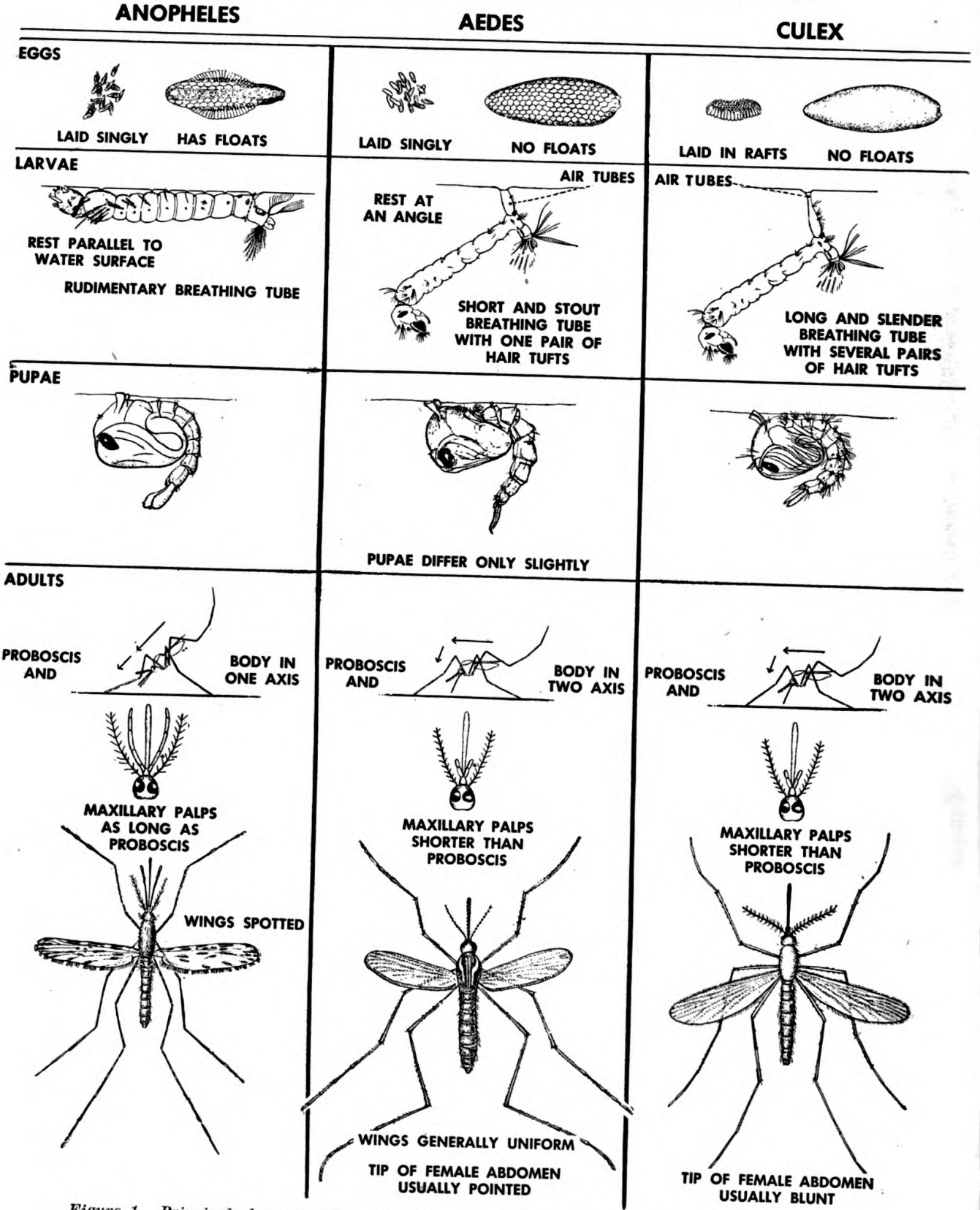


Figure 1. Principal characters for identifying the three mosquito genera of medical importance.

Figure 2. Typical mosquito-breeding area near woods.

Figure 3. Ponded rain water must be treated with mosquito larvicide or drained to prevent breeding on the post.

Figure 4. Drainage of mosquito-breeding waters improves living conditions for post personnel.

b. Potential sources of infective adult mosquitoes (inhabited localities).

c. Crops such as rice which require wet cultivation.

9. Control in Streams and Ponds

a. Stream Clearance. Although rapidly moving water does not generally have breeding sites, except for marginal pools, shallow, sluggish streams containing plant growth provide good conditions for mosquito development. Improving stream drainage is usually less expensive than other permanent measures. The following procedures are followed in improving stream conditions:

(1) Make a survey to determine that enough grade for flow is available.

(2) Beginning at upper end of stream, straighten and cut down banks at proper angle. (When accurate survey has been made work may begin at lower end.)

(3) Clear stream bed of vegetation and cut it to uniform grade. Make the channel deep and narrow.

(4) If stream is crooked, dig ditches to rechannel across its turns.

(5) Use the excavated dirt as fill at upper end of old channel. Make temporary dam of logs, stumps, or riprap to force stream through new ditch and prevent it from washing out the fill.

(6) If old channel is too extensive, fill only holes and low spots.

(7) Leave lower end of old channel open to complete its drainage into the new stream course. (See fig. 5.)

b. Stream Flushing (fig. 6). Another method of obtaining added water flow in a stream bed is by occasional flushing.

(1) Build small dam to hold back water.

(2) Periodically remove barrier.

(3) Use hand or mechanical removal of barrier, or an automatic siphon.

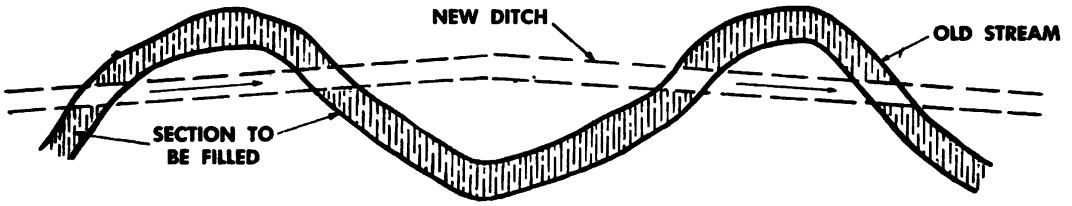
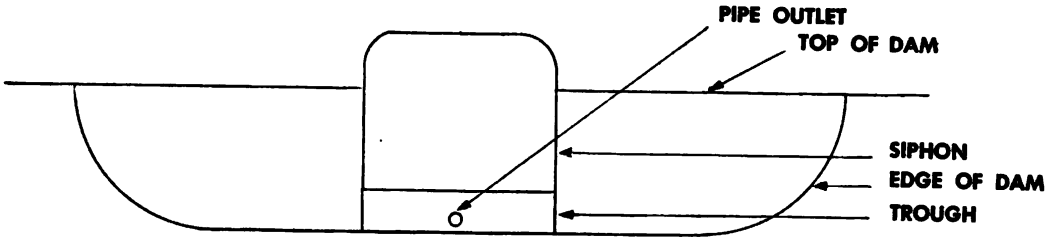
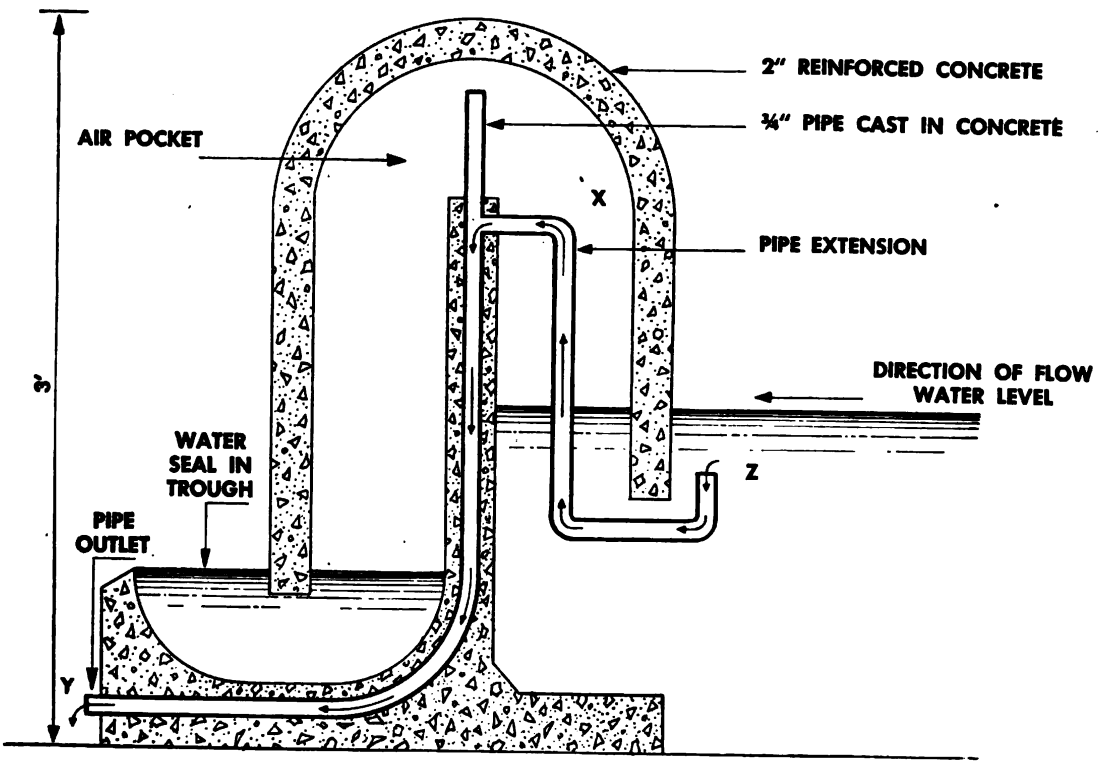


Figure 5. Rechanneling crooked streams.



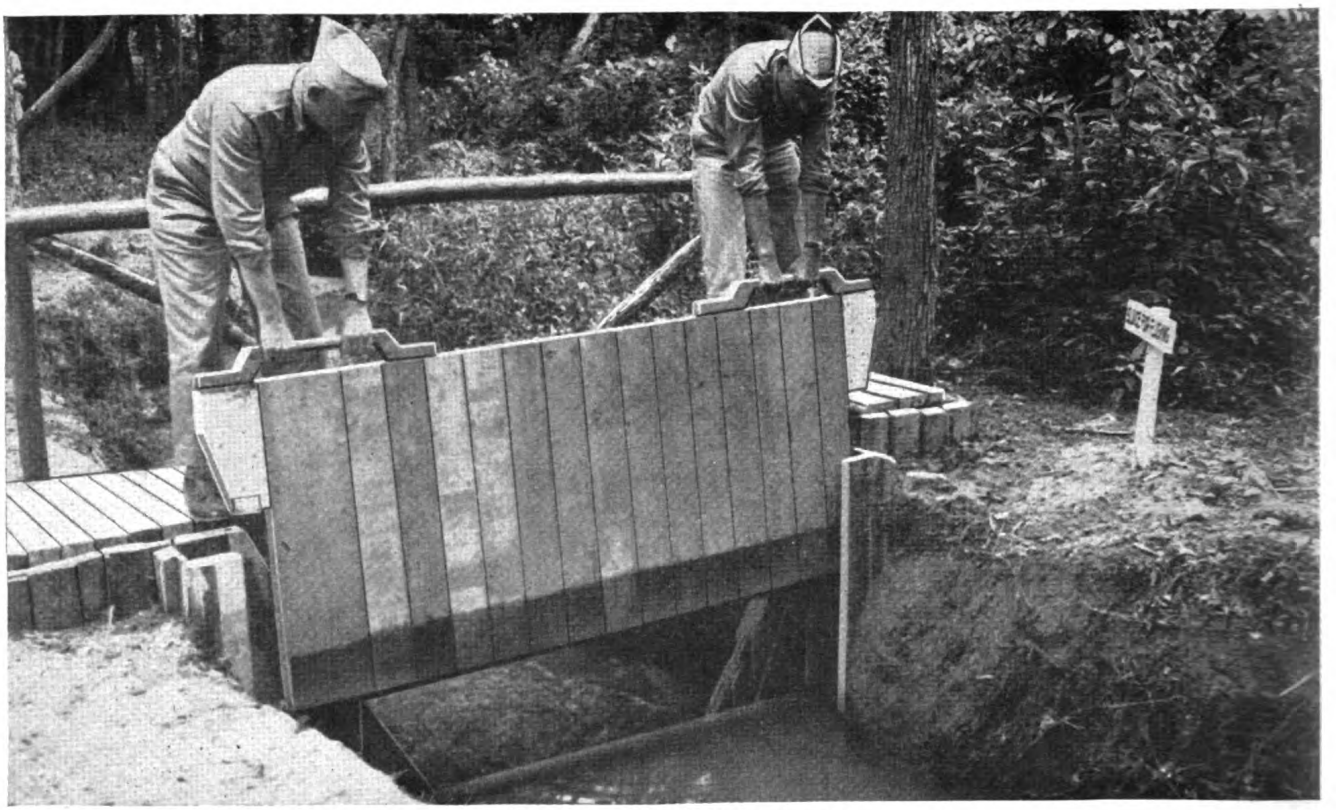
SIPHON IN DAM AS SEEN FROM DOWNSTREAM.



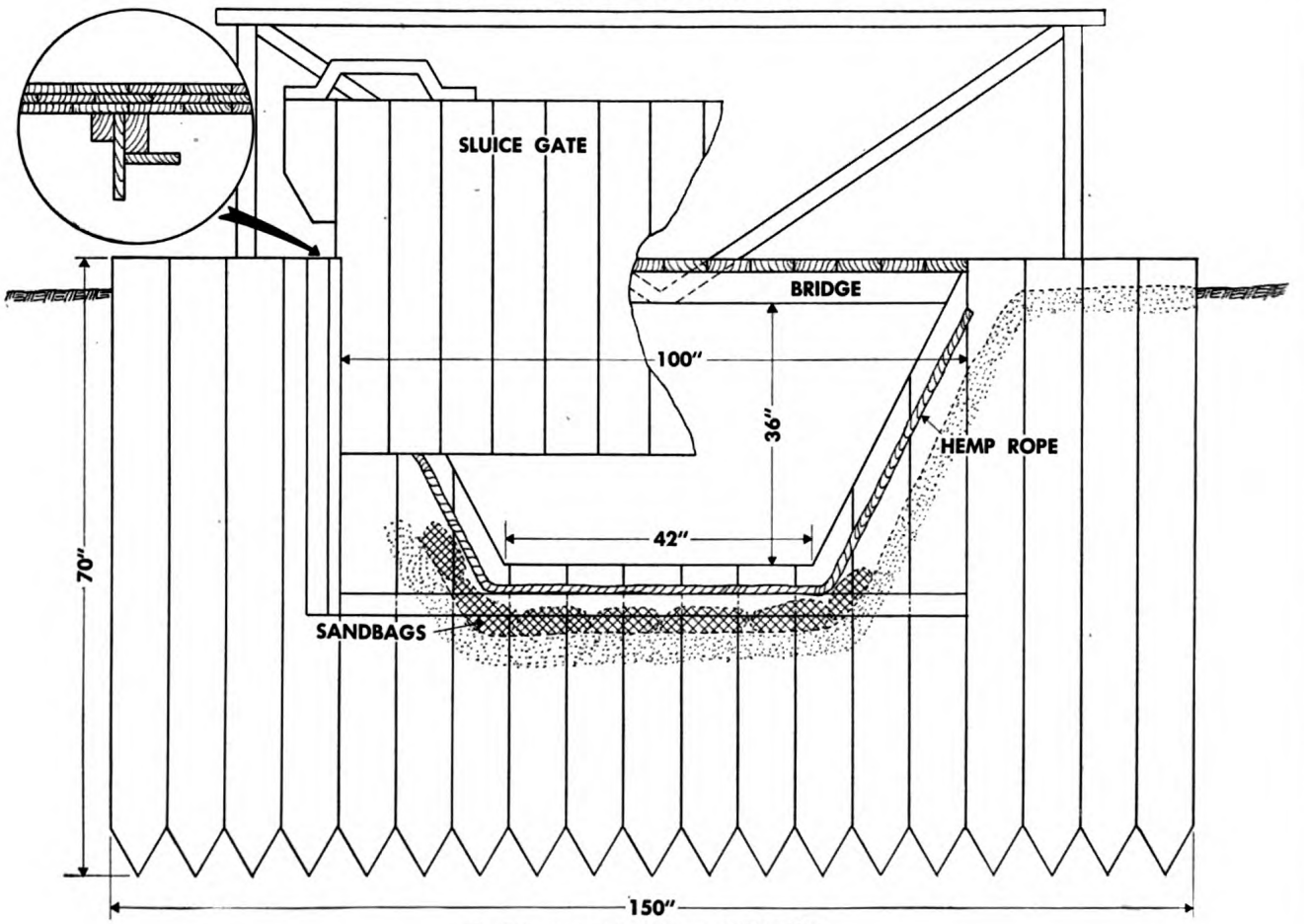
CROSS SECTION OF SIPHON

① *Diagram of automatic siphon.*

Figure 6.



② *Sluice gate for flushing streams.*



③ *Diagram of sluice construction.*

Figure 6—Continued.

c. Impounded Waters. Marginal infestation by mosquito larvae is controlled in reservoirs by alternately raising and lowering the water level to maintain a clean water surface and margin.

(1) Clear area to be used as a reservoir of all vegetation and organic waste matter.

(2) Start impounding at time of high water in spring.

(3) Lower water surface after marginal vegetation has grown. Larvae are stranded at edge of old level, drawn into deep water where they are destroyed, or carried to a new margin where no vegetation is growing.

(4) When new edge shows plant growth, lower or raise water level.

(5) Connect small pools left when water is lowered to main body of water by ditching.

d. Flood Waters (figs. 7 and 8). Seasonal flooding provides mosquito-breeding areas. Heavy rains may submerge meadows and swales which border rivers or ponds. Salt marshes are often flooded by high tides. Flood waters should be maintained at a fairly constant level or kept out of marginal areas by ditches, dikes, dams, and tide gates.

e. Salt Content. Where lagoons and bayous are close to the sea, opening channels to permit sea water to enter breeding areas is sometimes recommended to increase the salt content of the water, preventing further breeding of fresh water species.

f. Fish. Fish are sometimes used as a supplementary control measure against mosquito larvae. Because fish cannot catch mosquito larvae wrigglers easily if pond margins are overgrown, aquatic plants are removed so fish can move readily through the water. Common top minnows and killfishes are the most useful varieties.

10. Pumping

Pumping for drainage is recommended only when the general level of the area to be drained is the same as or below the water level of an adjacent body of water. Peat and muck soils that subside are examples of depressions lacking natural drainage. If several standing pools can easily be drained into one, water is pumped from this pool to the selected outfall.

11. Filling and Grading

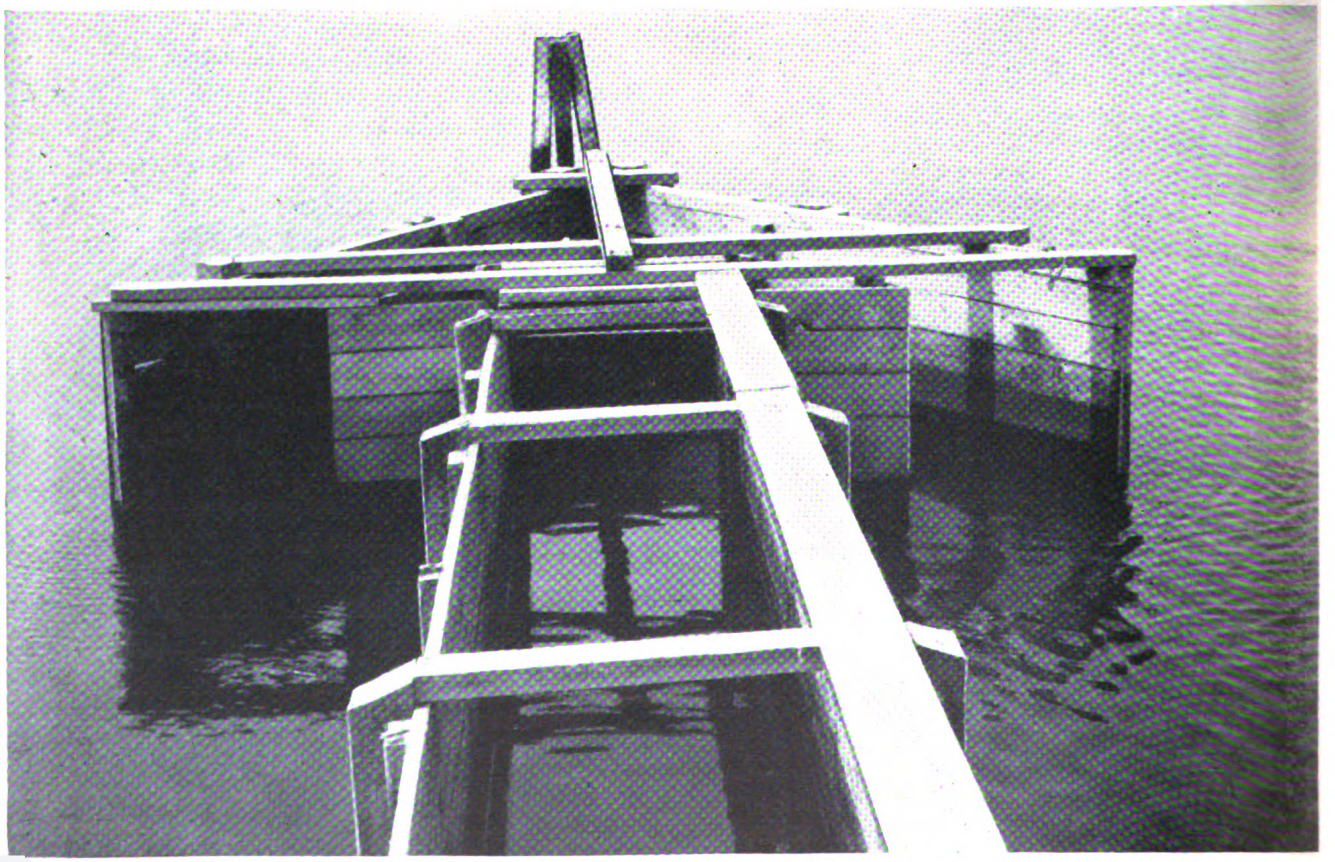
Mosquito breeding is prevented in small areas by filling and grading shallow pools and depressions found under buildings or beside roadways. Many of these depressions are made during construction work and should be filled by construction crews. Filling and grading is done with earth-moving equipment or by hydraulic filling. Many mosquito-breeding areas can be eliminated and the land reclaimed in coordination with sanitary fills for waste disposal. If hydraulic filling is recommended, natural drainage must not be blocked. Cracks and low areas are likely to form as the fill settles, and they may afford breeding places for mosquitoes if they become filled with water. Such areas either are surface graded after they have settled thoroughly or treated with larvicide. (See fig. 9.)

12. Ditching

Adequate ditching for mosquito control must remove water from the post area so ground surfaces become dry and ditch levels return to normal within a week after a storm. Soil texture, topography, vegetation, rainfall, and high tides in salt marshes are factors to be considered. Ditching plans should be coordinated on each post with grounds maintenance and road, railway, and runway construction. (See TM 5–630 and TM 5–624 when published.) Open ditches, unlike underground drains, remove large volumes of water rapidly, have low initial cost, operate where water table is high, and function well where drainage is temporary. However, they are subject to erosion and are expensive to maintain; if they are improperly designed or poorly constructed, they may form mosquito-breeding sites.

a. Planning Ditching Project. Ditch Construction for mosquito control is coordinated with other construction and maintenance work. The relation of the drainage system to water supplies, sewage disposal, quantity of water to be carried away in any period of maximum rainfall, and other sanitary measures must be considered. Because ditch maintenance is expensive, ditch layouts should be planned with as little footage as possible. However, a longer, shallower ditch following a natural depression is preferred to a shorter, deeper one through high ground because construction and maintenance costs are less and more efficient drainage is secured. Gentle curves are less likely to erode and are less difficult to maintain than abrupt ones. If a sharp curve cannot be avoided, outside banks are protected with stones or driven stakes and log revetment.

① *Tide and spill gate. It closes when the tide comes in.*



② *The spearhead prevents wave action from clogging outlet of drainage ditch.*

Figure 7.

Figure 8. A well-defined ditch cut in tidal marsh to drain surface water and pot holes.

(1) *Maps.* After the mosquito surveys are made, sketch maps should be prepared showing relative location of the project, including a profile of the outlet ditch. This profile should show ground elevation, grade of proposed ditch, and the cut at each station.

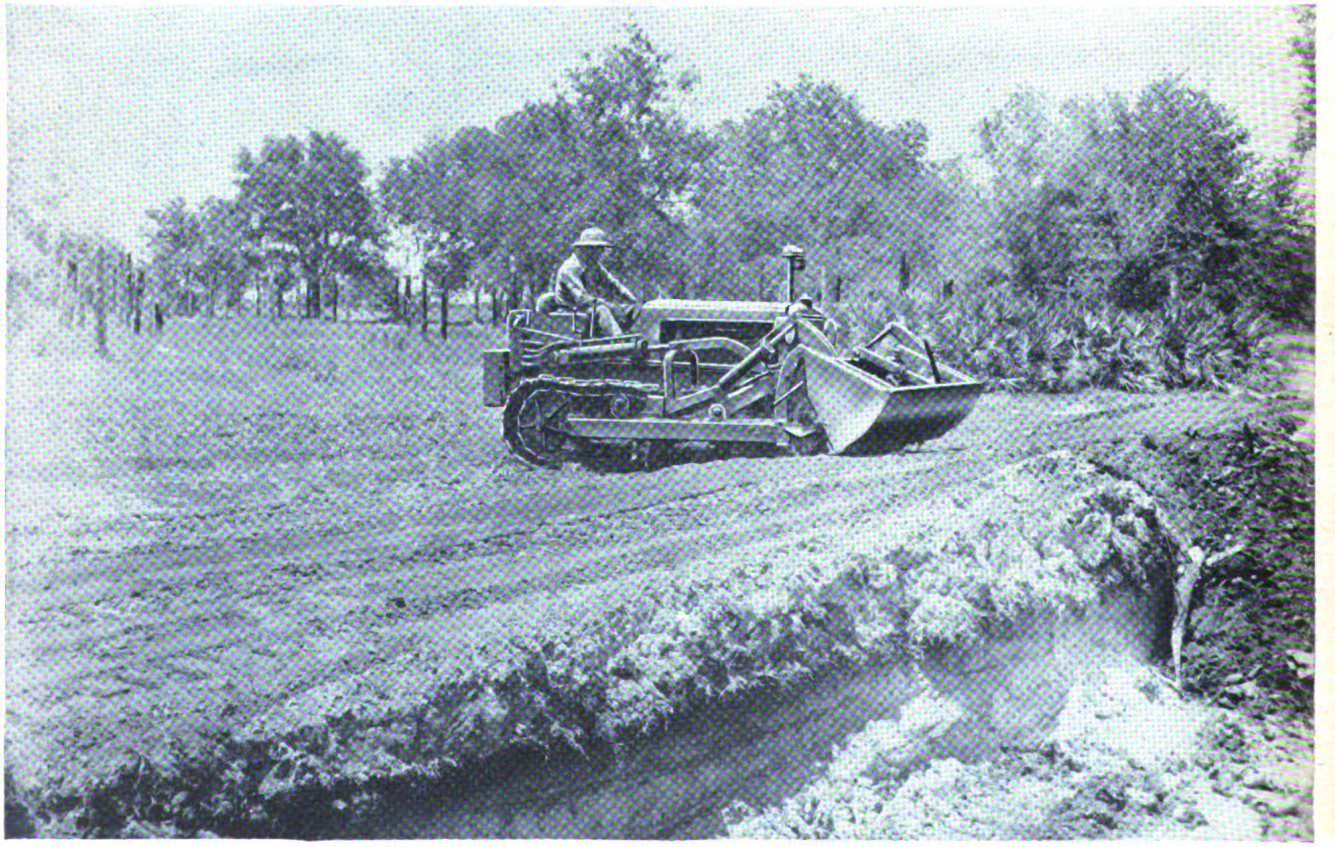
(2) *Discharge point.* An adequate outfall is located at a point where water no longer presents a mosquito-breeding hazard. The outfall should be low enough to provide adequate grade between the lowest point in the drainage area and the point of discharge.

(3) *Ditch levels* (fig. 10). Establishing proper grade is of fundamental importance in constructing drainage ditches, and adequate technical supervision must be provided. The gradient in an open ditch ordinarily is made as steep as possible without causing erosion of bottom and sides. An average water velocity of 2 to 3 feet a second usually prevents silting, yet does not cause erosion except in fine loose sands. Gradients over 1 foot to 100 feet are not usually recommended. When steeper grades are encountered, they can be reduced by check dams to lower the velocity of water flow. Grades less than 0.5 foot to 100 feet are not recommended. A ditch with a flat grade rapidly sets up conditions which favor mosquito breeding.

(4) *Location of desired grade* (fig. 11). To cut the ditch to the desired grade, a line should be set at a convenient height above the surface, parallel to the bottom of the finished ditch. This line is usually set an even number of feet above the grade of the ditch and stretched over batter boards across the ditch. This operation must be supervised by trained personnel.

(5) *Designing cross section* (fig. 12). Water velocity is controlled better by cross-section design than by grade regulation. The shape of the cross

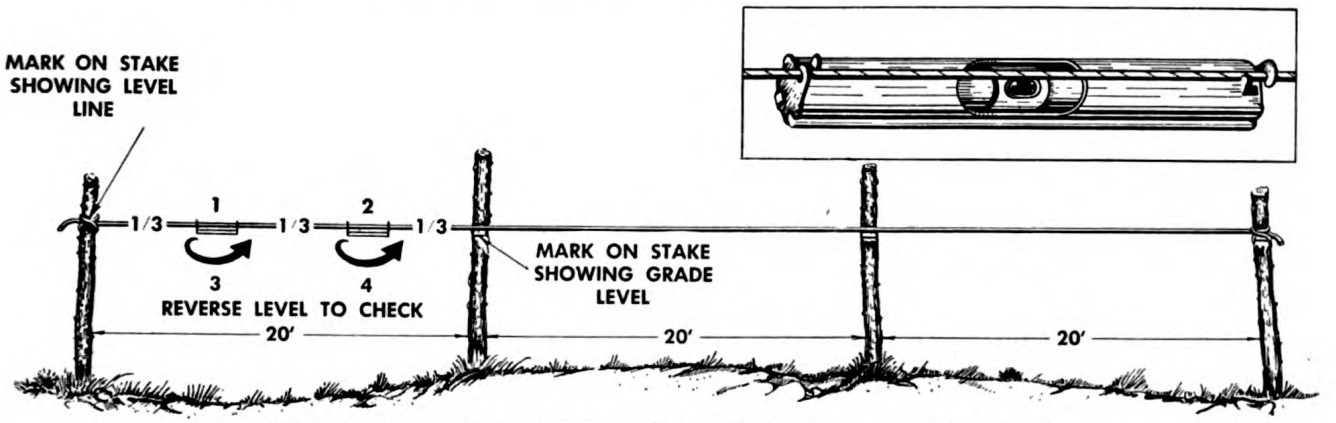
① *Water standing in cracks in hydraulic fills may breed great numbers of mosquitoes.*



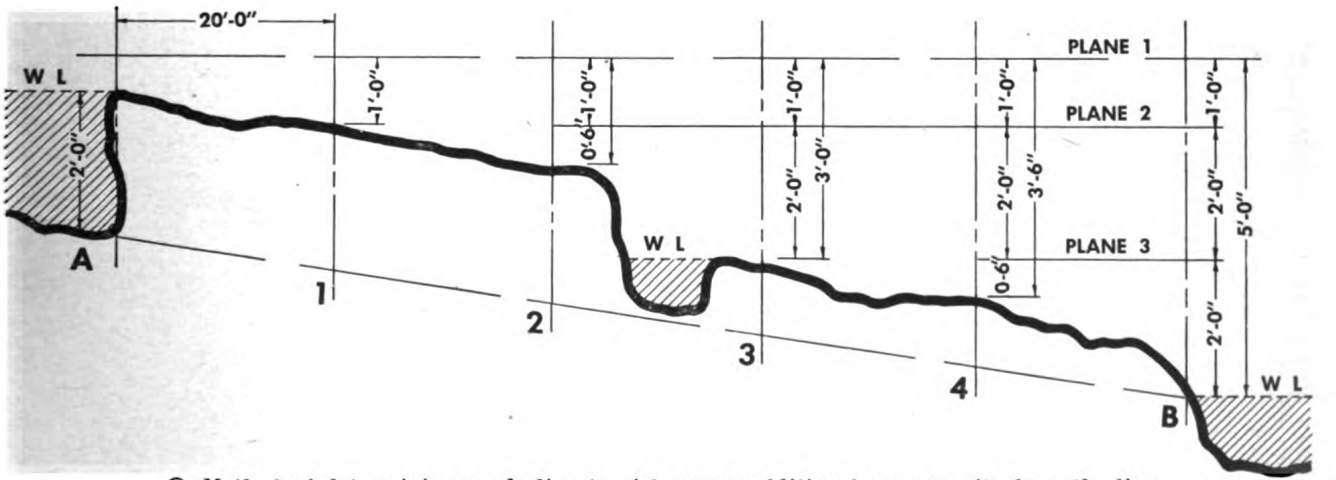
② *Filling mosquito-breeding area as a permanent control measure.*

Figure 9.

① *Plan for staking and running a level line and digging open drainage ditch.*



② *Method of determining grade line with hand or carpenter's level.*



③ *Method of determining grade line to pick up an additional seepage pit along the line.*

Figure 10.

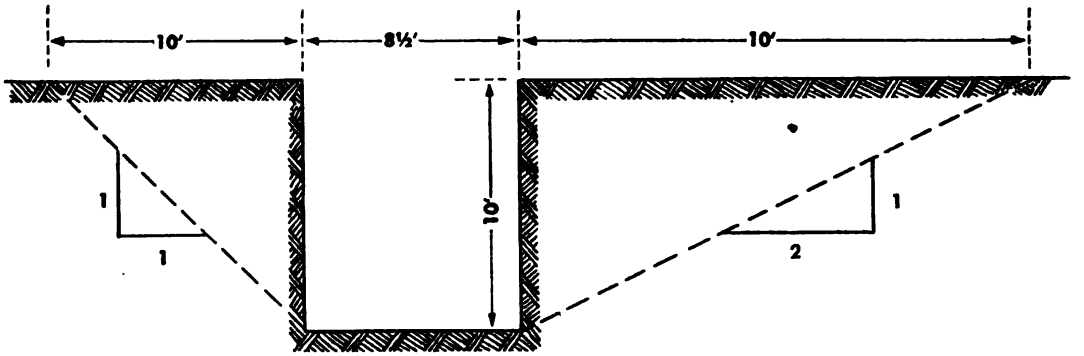
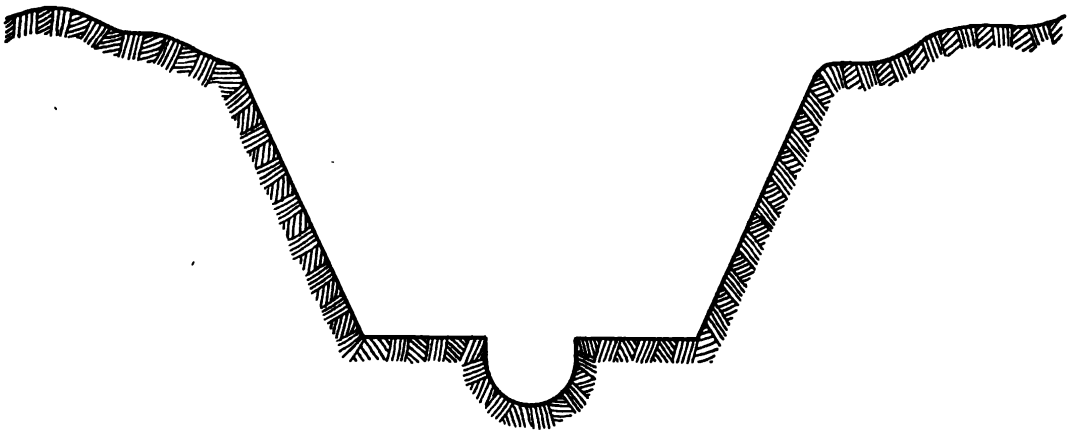


Figure 11. Line drawing of method for determining bank slope.

section should cause water to move rapidly for successful mosquito control. A V-shaped or U-shaped ditch bottom is recommended over a flat one because at low water during dry periods the flow is concentrated, velocity is increased, and silt deposits are reduced. Ditches may range in width from 12 to 14 inches for draining small ponds, to several feet for large areas. Small ditches that remove accumulated surface waters in 4 to 6 days are adequate. Since the flow of water increases from the upper to the lower end, ditch width in a drainage system of considerable length is increased gradually as the ditch proceeds down grade.

(6) *Ditch banks.* The slope of ditch banks may vary from a 2½:1 slope in stiff clay or matted roots to a 4:1 slope in sand. Where the soil is



INVERT DITCH

FLAT-BOTTOMED DITCH

Figure 12. Typical invert and flat-bottomed small ditches.

unstable, a flat slope cannot be maintained without such support as a line of poles securely pegged into the bank at the toe of the slope. Grassing by seeding, sprigging, or sodding is recommended for protection of unstable ditch banks. (See TM 5–630.)

b. Excavation (fig. 13). Construction of ditches usually begins at the outlet and proceeds upstream. The work is done by hand labor, power equipment, or dynamite. Construction details must be supplied by the supervisor. Excavated soil forming a spoil bank along a ditch is leveled off at some distance or placed to leave a berm 3 to 8 feet wide between ditch and spoil bank. The berm provides a path for maintenance crews and prevents the spoil bank from caving in or washing back into the ditch. Breaks must be provided in berms for surface drainage, and a lateral entering at an angle must be constructed if flow is sufficient.

(1) *Hand and machine labor* (fig. 14). Digging ditches deeper than 5 feet with hand labor is seldom satisfactory. Deeper ditches are dug with machinery, although the bottoms must be finished by hand. Ditches dug with dynamite usually contain loose material which requires shaping with hand tools after the sides and bottom become packed and stabilized.

(2) *Dynamiting* (fig. 15). Dynamiting is chiefly successful in soft, boggy, or sandy ground where hand or machine digging is difficult. Ditching with dynamite should not be attempted without expert technical assistance and a trained crew. Advantages of this method are as follows:

(*a*) Ditching through soil filled with roots and stumps is easier.

(*b*) Boggy ground not workable with a shovel can be ditched by dynamiting.

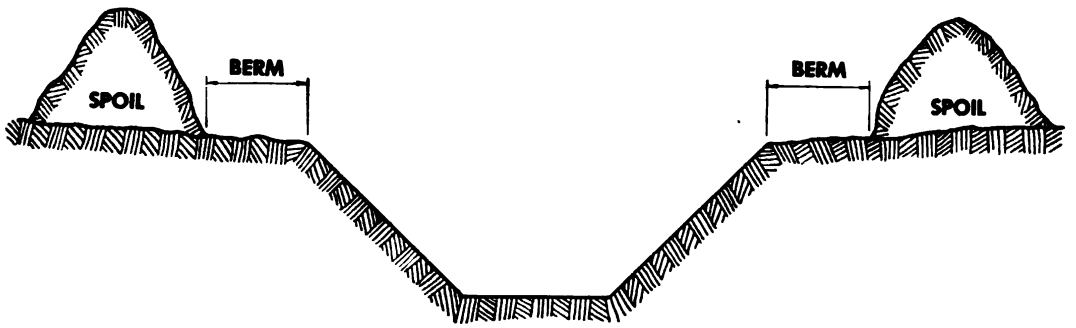
(*c*) Spoil is scattered.

(*d*) Ditching is rapid.

(*e*) Cost is less than for other methods.

c. Seepage Control (fig. 16). Seepage areas along hillsides are drained by locating a narrow contour ditch along the toe of the slope at right angles to the water flow, continuing the ditch along the outcrop until the seepage has been intercepted. The contour ditch is located by determining the level of the ground water causing the seepage with an earth auger or post-hole digger. Excavated soil is always placed on the side of the ditch away from the hill. If seepage areas are fed by springs, a separate lateral ditch is constructed to each spring.

d. Ditch Lining (fig. 17). To prevent erosion, open ditches are sometimes lined with concrete, broken native stone, logs or other durable material. This expensive practice is used only in exceptional circumstances. Along roadways and other locations where large volumes of rainfall must be drained but where continuous water flow does not exist, a shallow grass-lined ditch is often most economical. Narrow half-tile inverts are sometimes laid along the center line to remove residual water. From such ditches considerable water is absorbed directly into the soil, the grass not only protecting the soil surface but also retarding stream currents. Grass may be obtained by seeding, sprigging, or sodding. Chopped stolons of Bermuda grass mixed with 1 to 2 inches of topsoil and spread on the slopes of sandy ditches can give a vigorous stand of grass within 2 to 3 weeks. (See TM 5–630.)



LOCATION OF SPOIL BANK

Figure 13. Location of spoil bank and berm.

Figure 14. Ditch cut by power machinery.

e. Maintenance. The efficiency of an open-drainage system deteriorates seriously if ditches are not properly maintained. Maintenance is often carried on in winter to relieve the work load of the post engineer in summer when larvicides are applied.

f. Culverts (fig. 18). Culverts should be constructed so pools of water are not created to breed mosquitoes. The intake end of a culvert must be low enough to carry off all water from the high side of the fill. If rapidity of flow or difference in level at the lower end of the culvert is likely to creat potholes, an apron should be constructed.

g. Lateral Ditches. Lateral or branch ditches should enter the main ditch at an acute angle on a slightly steeper grade to prevent silting. Details of this operation should be obtained from the supervisor. Usually lateral ditches need be only one spade width at the bottom when they carry residual water to the main ditch.

13. Underground Drains

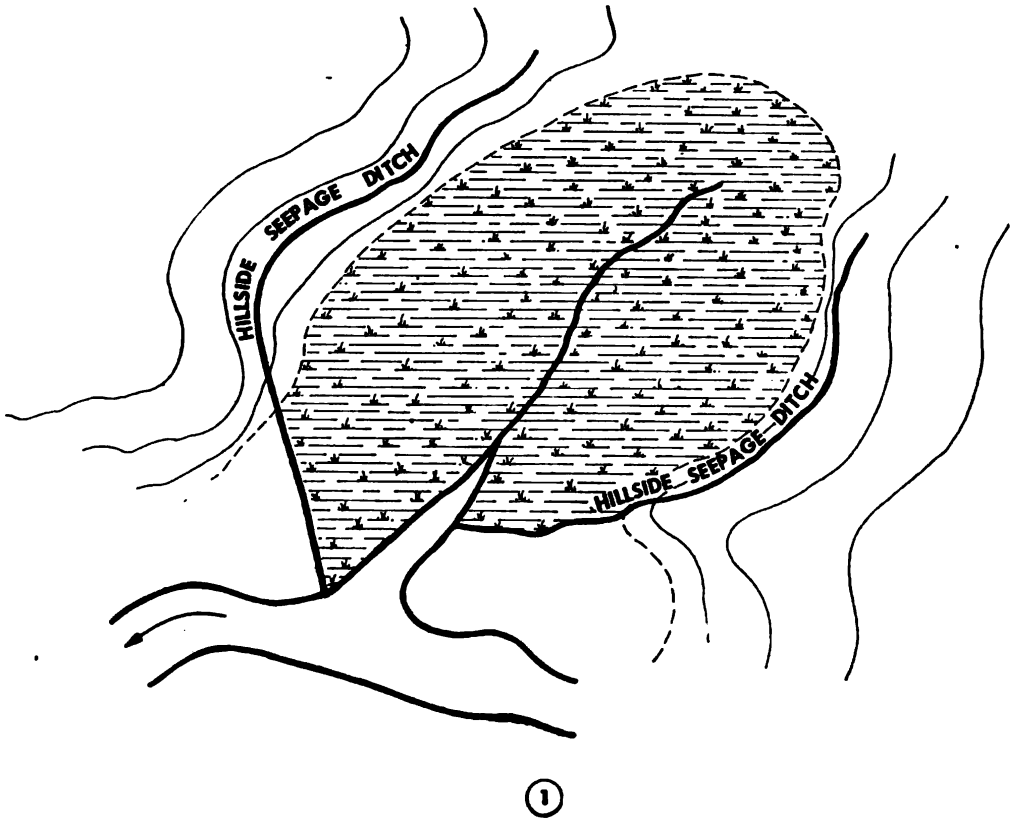
a. General. Small ponds, seepage areas, and swamps are sometimes drained by an underground system using drain tile, open-joint, or perforated tile, crushed or small-size rock, poles, or other material. When this method of drainage is recommended, careful technical supervision must be given to each job. Chief disadvantage of underground drains is that mosquito-breeding pools are sometimes in inaccessible places.

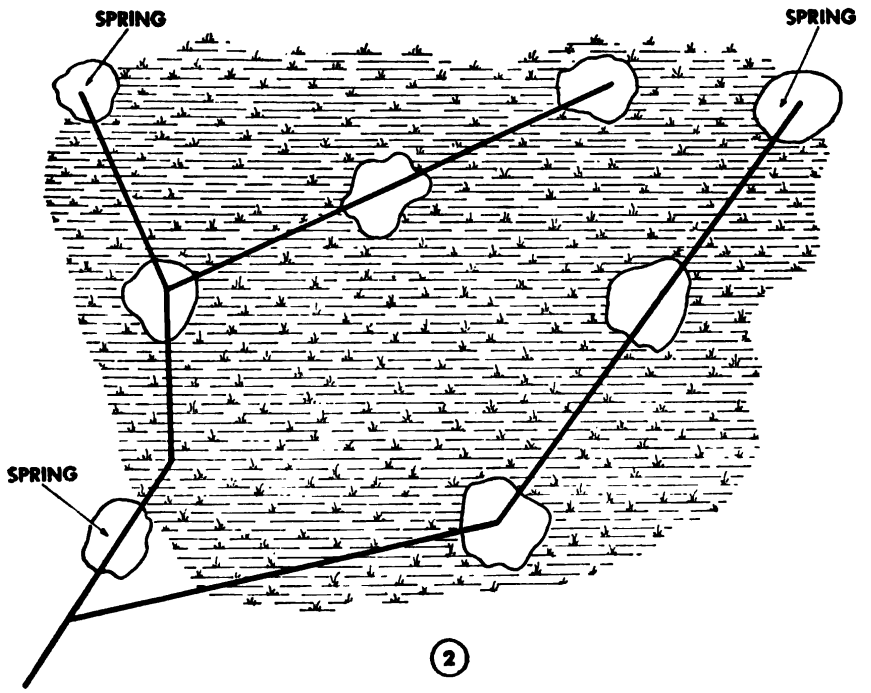
b. French Drains (fig. 19). French drains are economical and well adapted to drainage for mosquito control. Underground drainage is provided by the spaces between rock, coarse gravel, or poles 4 to 8 inches in diameter. These materials are

① *Land cleared to permit ditching with dynamite.*

② *Dynamited ditch immediately after blasting before slopes have been trimmed.*

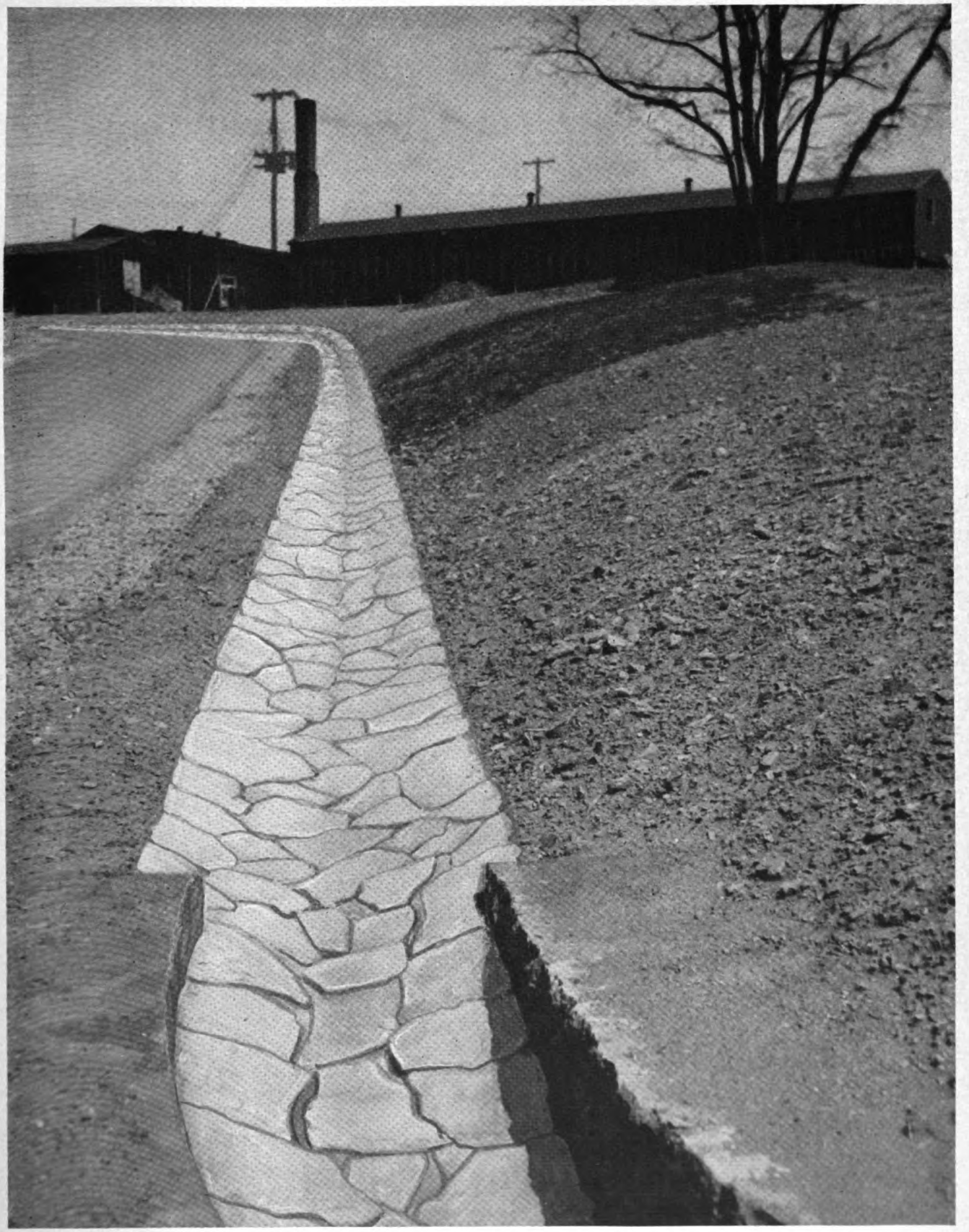
Figure 15.





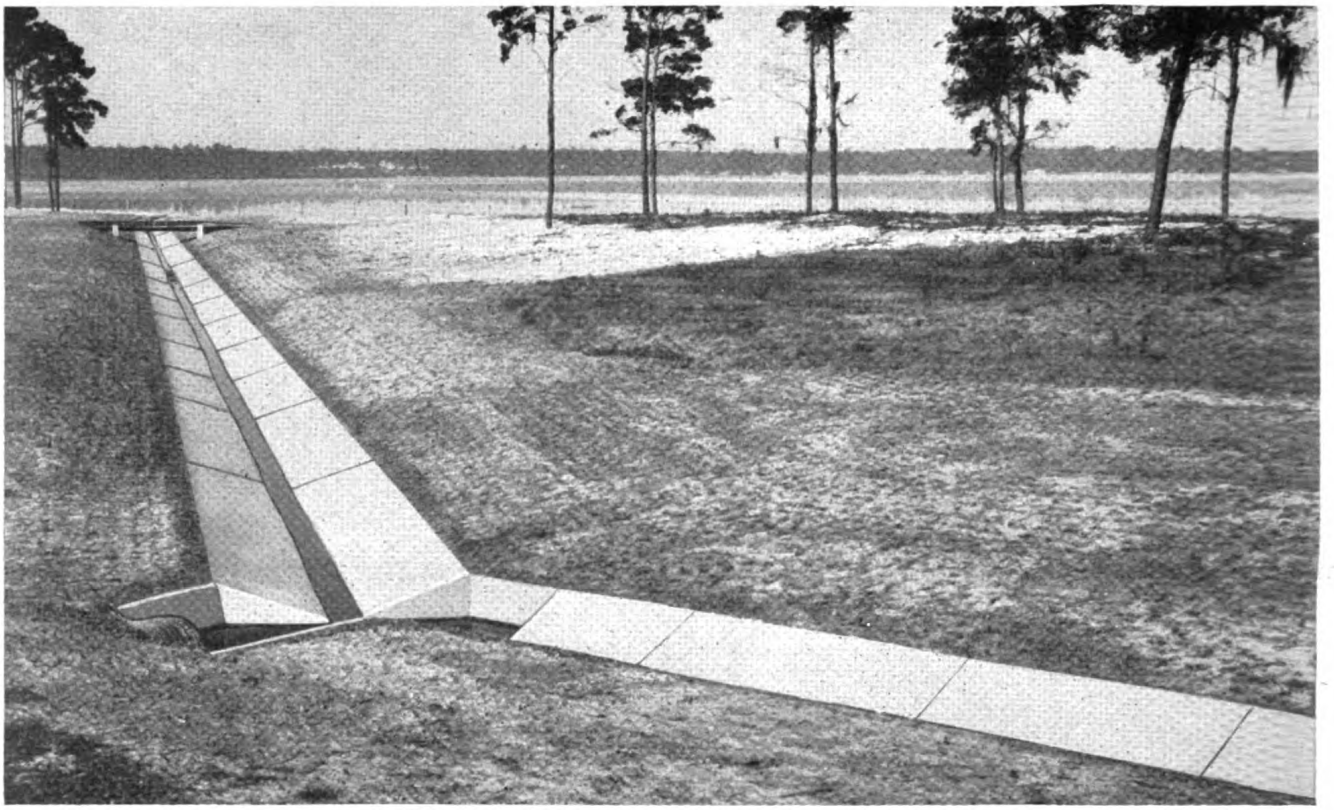
① *Hillside seepage ditches.* ② *Draining spring-fed marshes.*

Figure 16.



① *Ditch lining of broken native stone to check erosion on banks and on the outside of curves.*

Figure 17.



② *Ditch lining by precast concrete inverts about 3 inches thick, reinforced in unstable soil with chicken wire, steel mesh, or steel rods.*

Figure 17—Continued.

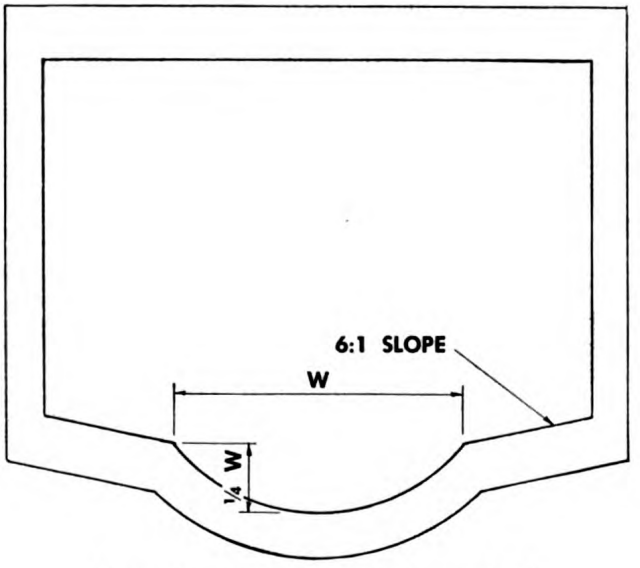


Figure 18. Typical round-bottom culvert.

surrounded by a porous filter of hay, weeds, leaf mold, or sand to facilitate movement of water into the drainage spaces and prevent soil from washing in to block the drain. If poles are used to provide spaces, the minimum number is five, three at the bottom and two on top. Joints at the ends of poles must not coincide. The filter must receive careful maintenance if the drain is to function properly. Poles or logs do not rot if they are continuously wet but soon decay if air reaches them. A log drain should end several feet from its outlet, the last few feet being tile or other material not subject to decay. An open, free-flowing outlet is necessary for underground drains.

Section III. TEMPORARY CONTROL METHODS

14. General

One of the most important temporary methods of mosquito control is the destruction of larvae by treating water surfaces with larvicidal oils and sprays. Dusting infested areas with insecticides and removal of land and aquatic vegetation are also practiced. These methods have immediate results and are sometimes used while permanent methods are being put into effect. The costs of a temporary control are so much less than permanent drainage that temporary measures can often be carried on for many years at less expense than

installation and maintenance of an adequate drainage system.

15. Use of DDT

Mosquito larvicides are applied about once a week to infested waters to control mosquitoes in immature stages. A 5 percent oil solution of DDT is the most effective. Dosage as low as 1 to 2 quarts an acre of water surface (0.1 to 0.2 pounds of DDT) is highly effective. For ease of application, the solution may be diluted to 1 percent with more oil and applied at the rate of 5 to 10 quarts an acre.

a. Advantages. Small quantities of DDT are adequate to control mosquito larvae over a large area, reducing problems of transportation and supply. DDT has a residual action, not possessed by other larvicides, of 3 to 6 weeks under some conditions if 5 percent DDT is applied at the rate of about 5 gallons. Its use makes temporary control less expensive and often more desirable than permanent measures.

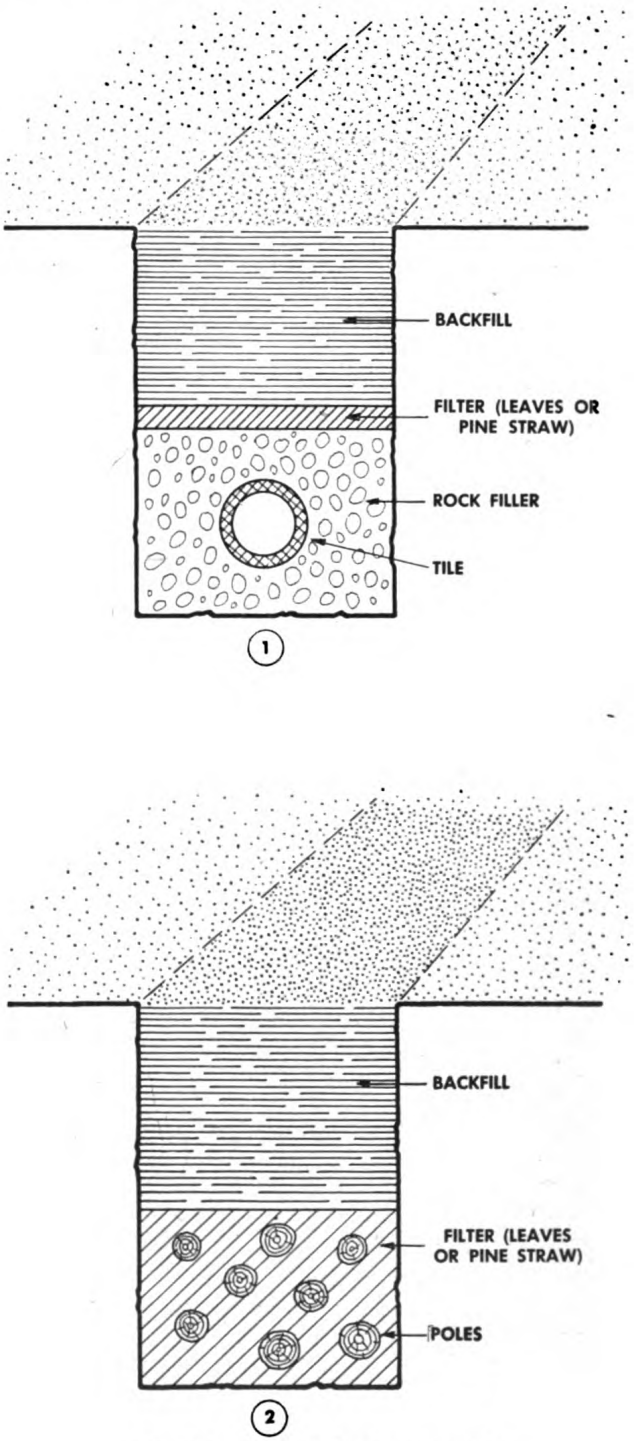
b. Supply. (1) The DDT issued for mosquito larviciding is QM stock No. 51–L–120; Larvicide DDT powder dissolving. It is the commercial grade 100 percent DDT powder, packaged in 10-pound metal containers. It can be dissolved in Diesel oil or kerosene to make a 5 percent solution of DDT for mosquito larviciding and for other uses in mosquito control.

(2) DDT dust can be obtained when recommended: QM stock No. 51–L–122; Larvicide, DDT, powder, dusting, containing 10 percent pulverized DDT in talc, packaged in 5-pound moistureproof metal containers. The powder is a stock mixture to be diluted with an inert diluent in making a dust of the desired strength. Generally a 2 percent DDT dust is recommended where a dusting powder is desired to control mosquito breeding.

c. Precautions. See paragraph 81.

d. Spraying with Ground-Operated Equipment (fig. 20). Larviciding with 5 percent DDT in oil is done largely with ground-operated equipment. In general, oil solutions of DDT are sprayed at the rate of 0.1 to .2 pound of DDT for each acre of water surface; this amount of DDT is contained in 1 quart and 2 quarts, respectively, of the 5 percent solution. This rate of application should be repeated every 6 to 9 days. Dosage of 5 gallons for each acre gives residual action under some conditions for 3 to 6 weeks. Knapsack sprayers, 3-gallon capacity, CE stock No. 41–7839.400–030, are recommended for DDT spraying. The spray nozzle is adjusted to obtain maximum drift over the water surface. Aperture of the spray-nozzle disks should be about $\frac{3}{64}$ inch.

e. Spraying by Airplane (fig. 21). To be effective, spraying DDT by airplane requires extensive ground work, proper ground conditions, and



① *Underground drain using tile.*
② *Underground drain using poles.*

Figure 19.

Figure 20. DDT kerosene spray is applied for mosquito control with knapsack sprayer.

plentiful supplies of material. Airplane spraying most useful in battle zones is also advantageous for treatment of large or inaccessible areas in the zone of the interior. Projects for the dispersal of DDT by aircraft must be approved by the Army Committee for Insect and Rodent Control, in accordance with section VI, WD Circular 207, 1945. (See fig. 21.)

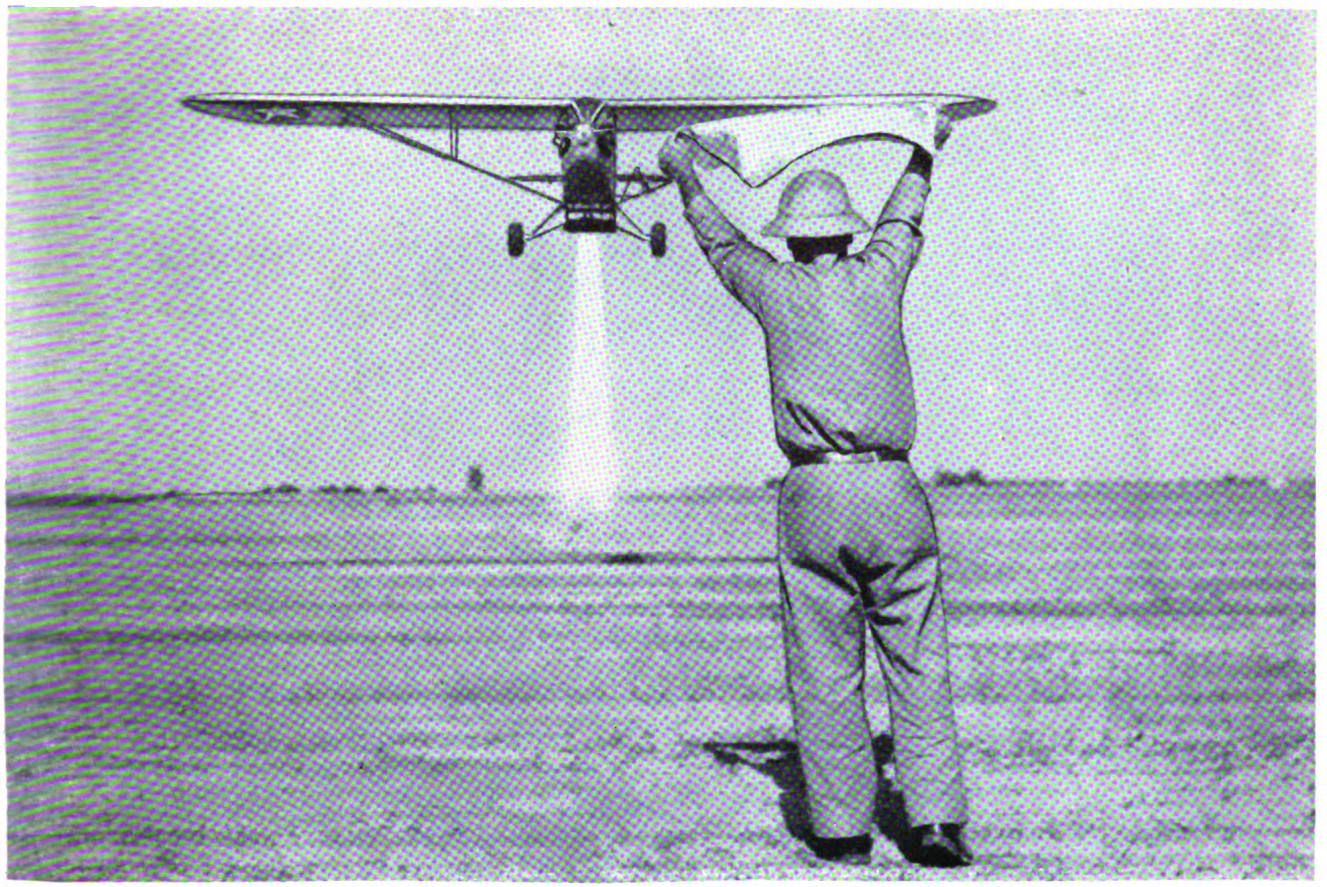
f. Dusts (fig. 22). A dust containing 1 to 5 percent DDT may be applied in the same manner as paris green dust. The quartermaster-issue dust mixture (10 percent DDT in talc) is diluted for use by adding a suitable inert carrier in the following proportions: For a 1 percent mixture, add 1 part of the 10 percent dust to 9 parts of carrier; for a 5 percent mixture, add 1 part of the 10 percent dust to 1 part of carrier. A hand-operated rotary type duster (CE stock No. 41–3115.500–100) is the most satisfactory duster for making applications. The dust is often applied to drift over the area being treated.

g. Dosage Rates. Quantities of DDT larvicides required for each acre of water surface to provide a given dosage are shown in the following summary:

DDT in solution or dust (%)	Total gallons liquid an acre to be applied		Total pounds dust an acre to be applied	
	DDT for 1 pound an acre	DDT for 0.1 pound an acre	DDT for 1 pound an acre	DDT for 0.1 pound an acre
1	12. 0	1. 20	100	10
2	6. 0	. 60	50	5
5	2. 4	. 24	20	2
10	1. 2	. 12	10	1

16. Use of Oils

Suitable oils can be used to control mosquito larvae if DDT is not available. Oil for this purpose should be inexpensive, yet toxic enough to kill the insects upon contact. Volatile oils, such as kerosene, are more toxic than nonvolatile ones although less persistent. When sprayed on the water surface the oil should spread in a uniform, persistent, stable film. To prevent clogging of spraying equipment, the oil must be free of grit and other foreign matter. Oils generally used are fuel oil or Diesel oil No. 2; kerosene, which may be colored with 1 part black oil to 20 parts kerosene; and waste oil, diluted half and half with kerosene. Use



① *Application of DDT mosquito larvicide by slow-speed airplanes.*

② *Knapsack spraying of mosquito breeding ponds covered with a heavy growth.*

Figure 21.

③ *Oil-packed sawdust bags for a continuous application of mosquito larvicide over breeding areas.*
Figure 21—Continued.

of waste motor oil, however, is not generally recommended because it is not very toxic, tends to clog the sprayer, requires costly handling, and does not spread evenly on the water surface. The following are specifications for a good larvicidal oil:

Specific gravity (20/4)	0.83 to 0.86
Viscosity (Saybolt Universal at 100° F.)	31 to 43
Initial boiling point	297° F. to 414° F.
Final boiling point (maximum)	800° F.
Spreading coefficient (minimum)	17.0

a. With a knapsack sprayer one laborer can oil about 1½ acres a day. Over a full season, the average amount an acre for each application is from 15 to 20 gallons, although some situations may require up to 35 gallons an acre.

b. The oil is usually applied by spraying on the water surface. The knapsack sprayer (CE stock No. 41–7839–400–030) with a capacity of 3 gallons and a spraying range of about 25 feet is an economical apparatus for oiling ditches and other small bodies of water. (See fig. 23.) Power sprayers (CE stock No. 40–9030.6–3) or boats may be especially adapted to oiling more extensive areas such as the margins of ponds and swampy areas.

17. Care of Water Containers

Articles such as tin cans that may contain water should be removed or drained. Open dumping of waste materials that hold water provides a breeding place for mosquitoes. Roof gutters and other necessary equipment that retain water require cleaning. Cisterns, wells, reservoirs, water cans, fire barrels, and ornamental pools are sometimes sources of mosquito breeding. Catch-basins not constructed to be self-draining, and water-filled traps in drains exposed to mosquito breeding should be flushed periodically or treated with larvicide. Borrow pits should never be constructed without provision for proper drainage.

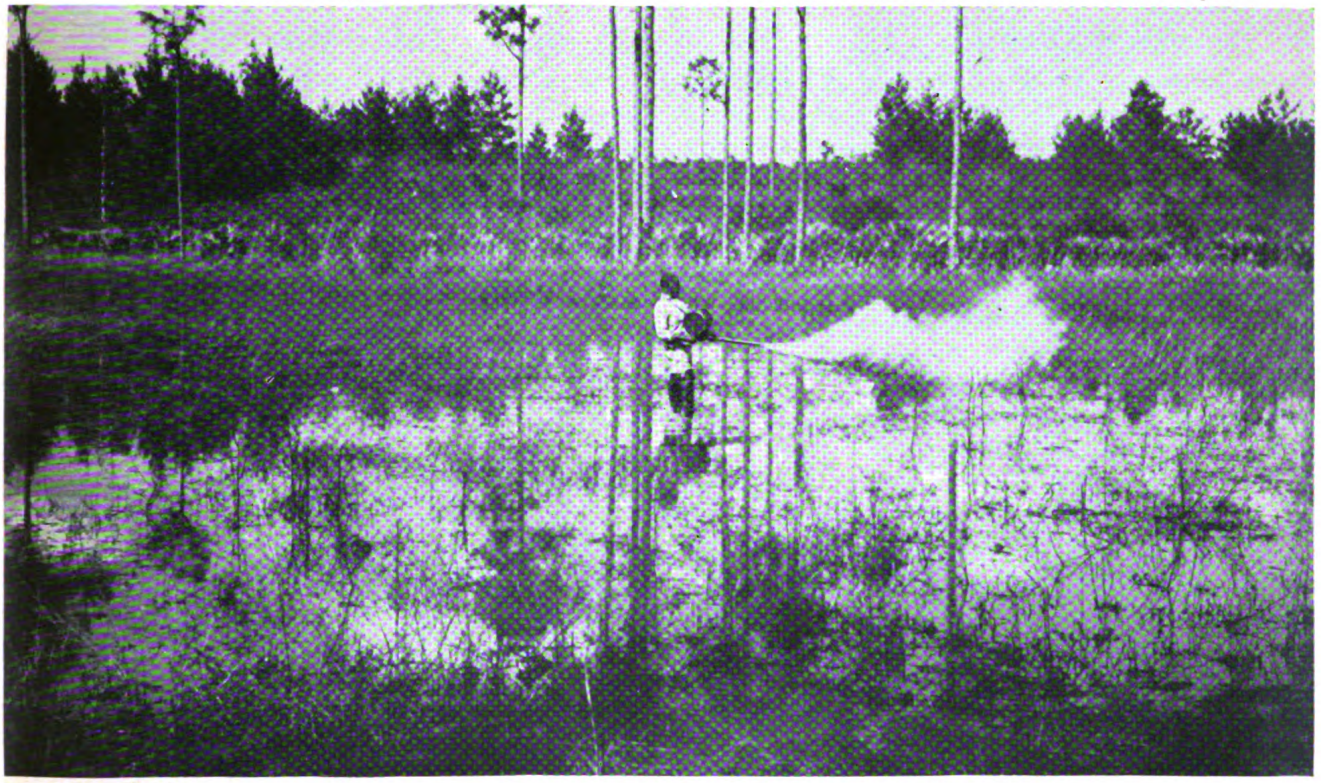


Figure 22. Applying DDT dust on mosquito-breeding pond for control of Anopheles mosquitoes.

Figure 23. Mosquitoes may breed in drainage ditches unless prevented by larvicidal applications.

Section IV. CONTROL OF ADULT MOSQUITOES

18. General

Mosquito-control methods discussed in preceding paragraphs destroy the larvae or eliminate their breeding places. Other procedures, including sprays applied indoors and outdoors and adequate screening of buildings, are used to control adult mosquitoes and prevent their bites. Personnel occupying the buildings as well as post engineer personnel are concerned with this type of control.

19. Indoor Control

Application of 5 percent DDT in oil solution is a highly effective residual spray for adult mosquitoes; applications of pyrethrum or substitutes for pyrethrum are also effective although they have only momentary effect. These insecticides are sometimes used together to good advantage. DDT sprays applied to the surface of walls, ceilings, and furniture kill mosquitoes and many other insects that come to rest on these surfaces. DDT has a remarkable residual effect. Pyrethrum sprays, and thiocyanates, destroy adult mosquitoes quickly in confined or semiconfined spaces (QM stock No. 51–I–169: Insecticide, liquid, finished spray) as do sprays dispersed by the aerosol insecticide dispenser, QM 51–I–159.

a. DDT Method. Five percent DDT in oil as a residual spray is applied to all surfaces where mosquitoes are likely to rest. Screen doors, windows, light cords, ceilings, corners, closets, and the undersurfaces of chairs, tables, and beds should receive special treatment. Recommended dosage of 1 quart of 5 percent DDT solution to 250 square feet is expected to provide a residue of DDT of about 200 milligrams a square foot and be effective up to 3 months on interior surfaces. The surfaces should be sprayed until wet, but not enough to cause runoff. Application should be made with a nozzle giving a fine wet spray without clogging. The nozzle should be held about 8 inches from the surface.

b. Space Sprays. Pyrethrum or thiocyanate sprays kill by contact with mosquitoes but have no appreciable residual effect. Adult mosquitoes coming in contact with these sprays are knocked down almost immediately. These contact sprays are applied with hand sprayers in barracks or other buildings at military installations when immediate kill of mosquitoes is desired. The aerosol dispenser (QM 51–I–159) is also highly effective for this purpose.

20. Outdoor Control With DDT

Post engineers may be called upon to apply control measures for adult mosquitoes outdoors. A 5-percent DDT solution in oil kills mosquitoes resting on vegetation or in other hiding places if properly distributed. This treatment also kills insects that later come to rest on the sprayed surfaces. Dosage recommendations for outdoor adult mosquito control may be obtained from service command headquarters. DDT sprays can be applied by such ground-operated equipment as knapsack and power sprayers, or by airplanes. Spray apparatus for use in airplanes is being developed and standardized by the AAF.

21. Screens

Most types of wire screening are made of steel-wire cloth, either painted or electrogalvanized. The quality of paint and of galvanizing varies greatly for different lots of wire. Wire should be noncorrosive, weather-resistant material such as copper, bronze, aluminum, or a suitable plastic.

a. Mesh Size. The diameter of wire and size of screen openings are important. Screens having apertures no larger than 0.0475 inch in diameter are recommended. Ordinary wire screen must have at least 18 meshes to the inch and heavy copper screen must have 16 meshes to the inch with a wire diameter of 0.015 inch to meet this requirement. Regular 16-mesh screen, ordinarily produced from finer wire, has openings too large. Standard 18-mesh wire screen has a wire diameter of 0.009 to 0.010 inch and meshes 0.0456 inch across, excluding both malaria-carrying mosquitoes and the smaller pest species.

b. Screen Construction (fig. 24). Screen doors that open outward are recommended for Army buildings. On new construction or for repair of existing doors the combination screen and solid panel door (CE drawing No. 700–3145, 3 April 1944) should be installed. Screens must be fitted carefully to insure their being mosquitoproof. When copper screen is used, the frames cannot be painted with a zinc-base paint or fastened with galvanized nails because an electrolytic reaction is set up which splits the screen away from the frame. This splitting is avoided by using lead-base paint and nongalvanized nails. Rents and tears in screens must be repaired promptly.

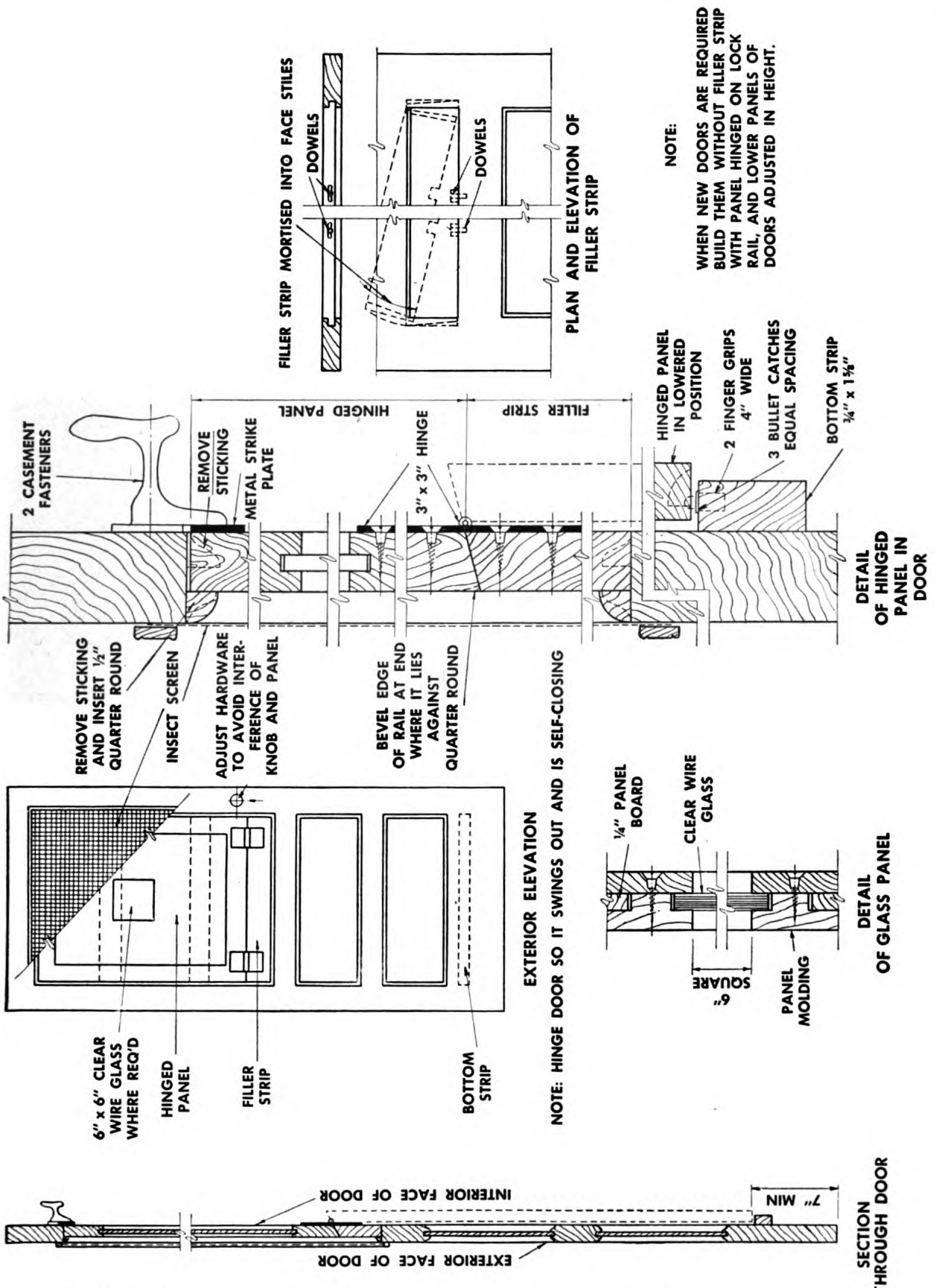


Figure 24. Combination screen and solid-panel door for protection against mosquitoes and flies.

CHAPTER 3
FLIES

22. General

Flies are annoying pests and disease carriers, the three most important diseases transmitted being dysentery, diarrhea, and typhoid fever. They are two-winged insects having four stages of development; egg, larva, pupa, and adult. The larva is a whitish maggot, usually feeding in moist, decaying organic matter.

23. Kinds of Flies

The three kinds of flies chiefly found on Army posts are the housefly, blowfly, and stable fly.

a. Housefly (fig. 25). The common housefly often comprises as high as 98 percent of all flies which appear indoors. Breeding in animal and vegetable refuse, the white maggots occur in masses in any damp organic material which offers food for development. Under warm weather conditions, the housefly develops from egg to adult within 10 days. The adult feeds on organic filth or human foodstuffs. Coming in contact with human excrement, the fly becomes contaminated with disease organisms which are carried on its feet or in its excrement to food and mess hall utensils. Because the fly can take only liquid foods, it regurgitates while feeding on solid material to dissolve the solids, further contaminating food. The housefly may travel a mile or more from its breeding place in search of food.

b. Blowfly. Blowflies, as well as greenbottle and bluebottle flies, breed in decaying meat and fish and sometimes animal and human excrement. The adult flies often occur in large numbers around improperly maintained latrines.

c. Stable Fly. The stable fly, or dogfly, is a biting species frequently mistaken for the housefly. It breeds normally in wet straw, manure mixed with straw, or any piled and rotting vegetation such as grass, seaweed, and similar materials. It does not frequent latrines and is not reported to be a transmitter of human disease. In some localities it breeds in sufficient numbers to annoy men and animals considerably.

24. Control of Houseflies

Good housekeeping and proper policing of the grounds are of utmost importance to fly control; elimination of all unnecessary sources of attraction is essential on Army posts.

Any fermenting or decaying organic matter and garbage such as human and animal excrement, dead animals, fish and meat refuse, or discarded foodstuffs are breeding places for flies. Such materials should be confined in appropriate containers and properly disposed of as soon as possible.

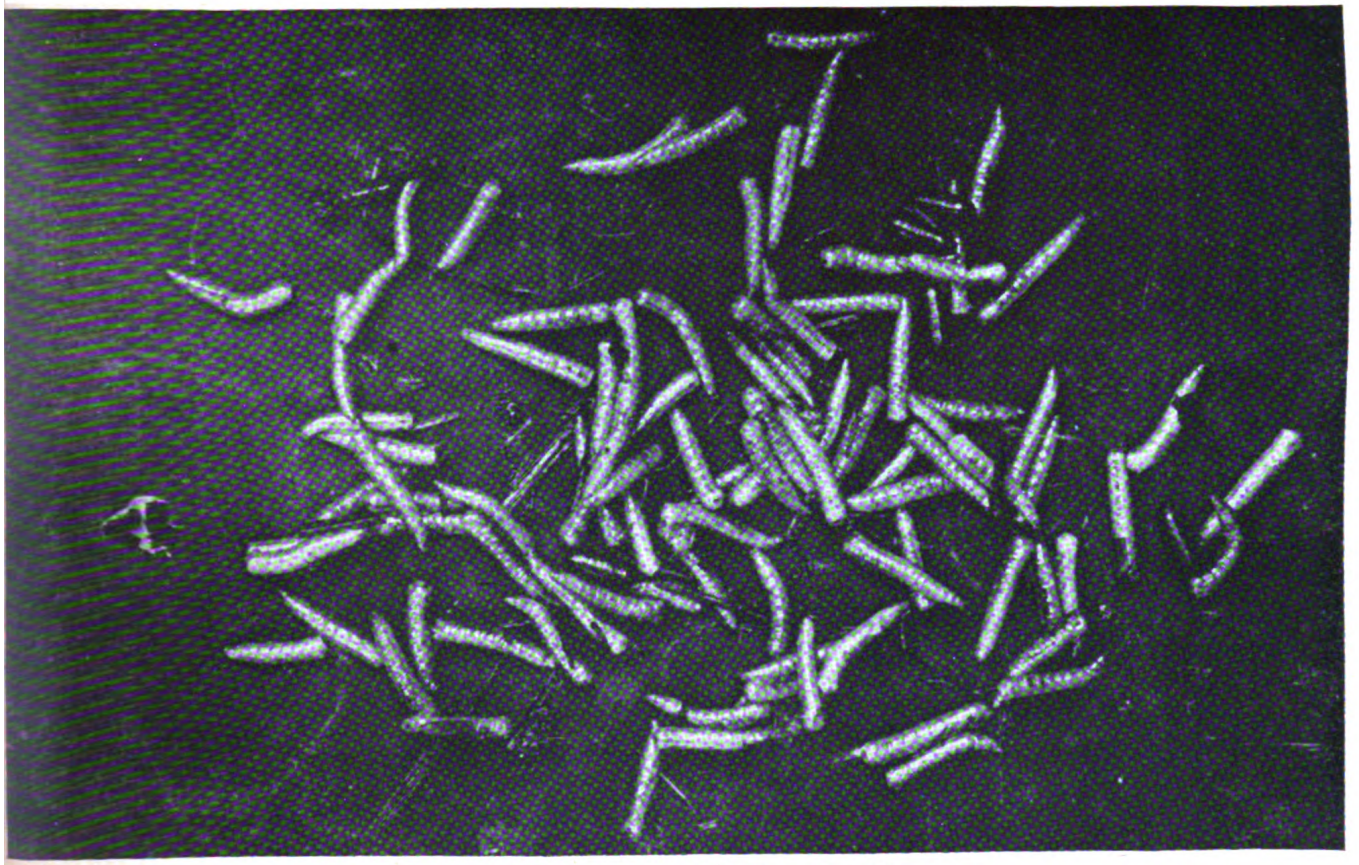
a. Disposal of Kitchen Wastes. Proper disposal of kitchen wastes is highly essential to prevent the attraction of flies to the mess hall area. (See fig. 26.) These wastes include all garbage and such liquids as wash water. Garbage must be deposited in garbage cans equipped with well-fitted lids. These cans are kept outside the mess, preferably off the ground on a stand or rack. Garbage racks and surrounding ground surface should be sprayed with 5 percent DDT in kerosene.

(1) An effective method of permanent disposal of inedible garbage, nonsalvable waste, and rubbish is the sanitary fill. Sanitary fills should be installed and operated as shown in TM 5–634 (when published).

(2) Disposal by incineration may also be approved but care must be taken to insure complete incineration lest fly breeding be increased rather than diminished.

b. Treatment of breeding places. Applications of DDT residual spray should be made at the rate of 1 quart per 250 square feet (200 milligrams DDT per square foot), to the ground and inclosures around latrines, garbage racks, and any other places subject to fly breeding. Pit latrines should be treated by spraying walls inside and outside of pit and box, and the walls and screens of the inclosure. Application of 2 ounces of residual DDT spray or 1 ounce of 10 percent DDT powder to standard latrine box controls fly breeding.

c. Screening. Some flies migrate into areas or develop there in spite of efforts to destroy their



① *Housefly larvae growing in garbage and filth.*

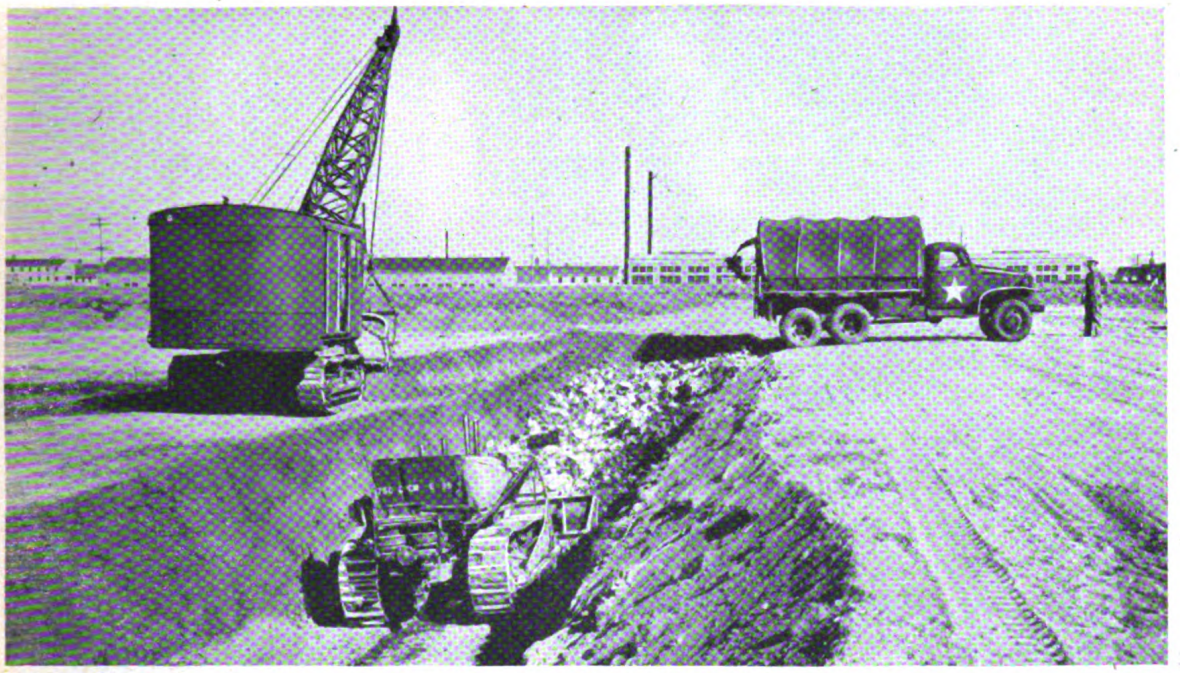
② *Houseflies feeding from sugar bowl.*

Figure 25.

① *Garbage and waste improperly disposed of breed millions of houseflies.*

② *Garbage, manure, and other moist organic material in hog-feeding pens may become a breeding ground for houseflies.*

Figure 26.



③ *Sanitary fill eliminates the open dump and with it the breeding of flies and rats on the post.*

Figure 26—Continued.

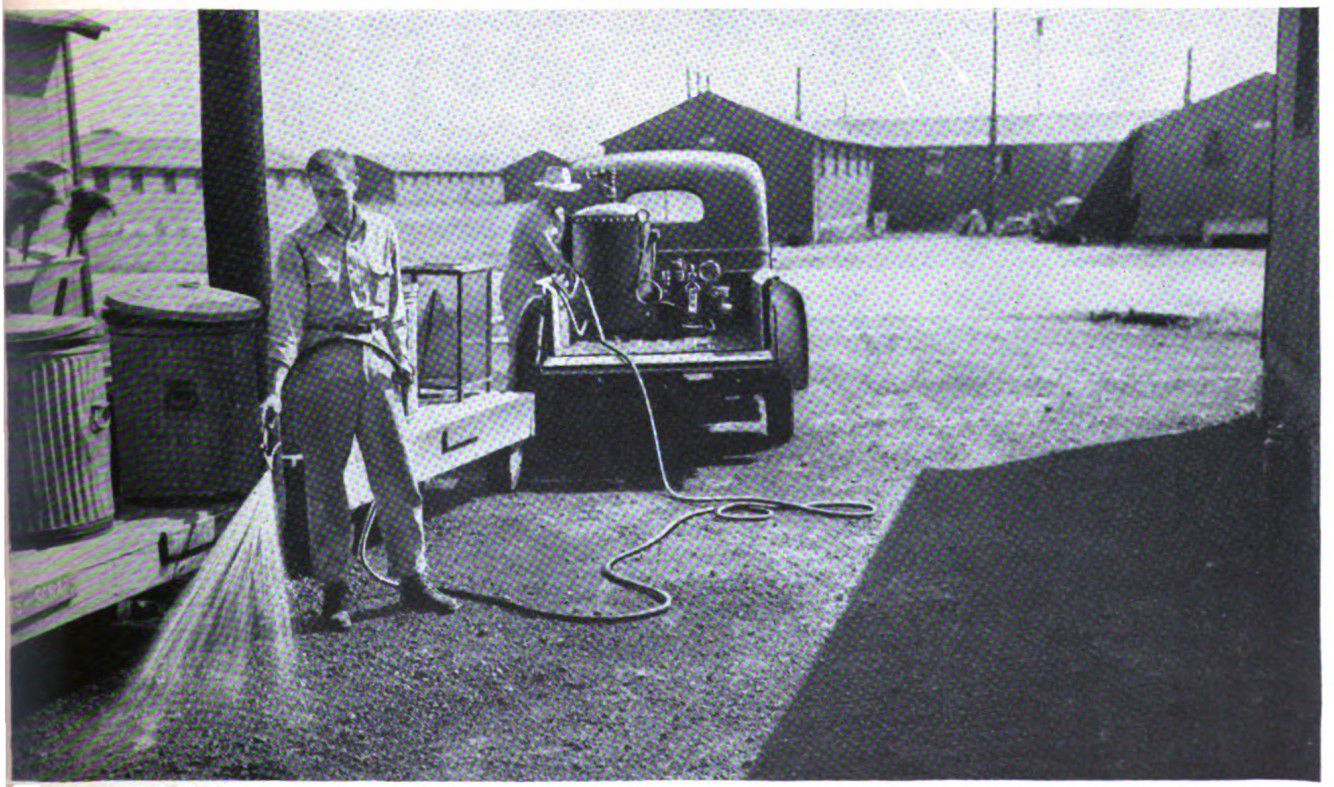


Figure 27. To destroy flies, spray loading platforms, garbage cans, and soil around racks with 5 percent DDT in kerosene.

breeding places. They must be prevented from coming in contact with food and drink. All buildings on Army posts should be screened to exclude flies. Screens should have a mesh of 18 wires to the inch, which also keeps out mosquitoes. The same precautions are observed for the installation and maintenance of screening as given in paragraph 21.

d. DDT Sprays In Buildings (figs. 28 and 29). Flies in mess halls and other buildings are readily killed by DDT spray residues. Apply 5 percent DDT in kerosene to interior surfaces of walls in mess halls, latrines, and other places where flies congregate. Need of spray may be determined by examining rafters, light fixtures, and ceiling projections for fly specks. The dosage rate is 1 quart to 250 square feet which leaves a residual deposit of about 200 milligrams of DDT a square foot. This recommended rate of application controls flies on the sprayed surfaces for a period up to 3 months. Application should also be made by sprayer or paint brush to all screens on doors and windows. If this spray is diluted to 2.5 percent to prevent forming unsightly residue, it must be renewed once or twice a month because it is removed by the scrubbing action of rain. Several types of spray equipment, including the 3-gallon knapsack sprayer, may be used to apply DDT in kerosene. (See fig. 30.) Air pressure should not exceed 20 to 40 pounds, and spray nozzles should be adjusted to provide a wet spray. Power spray equipment often produces too much fogging. The liquid spray is applied directly on the wall with the nozzle held about 4 to 8 inches from the surface. Freshly painted surfaces should not be sprayed. Operators should wear approved respirators and other protective devices when applying DDT. Exposed food and utensils should be covered to prevent contamination by the spray. (See par. 81.)

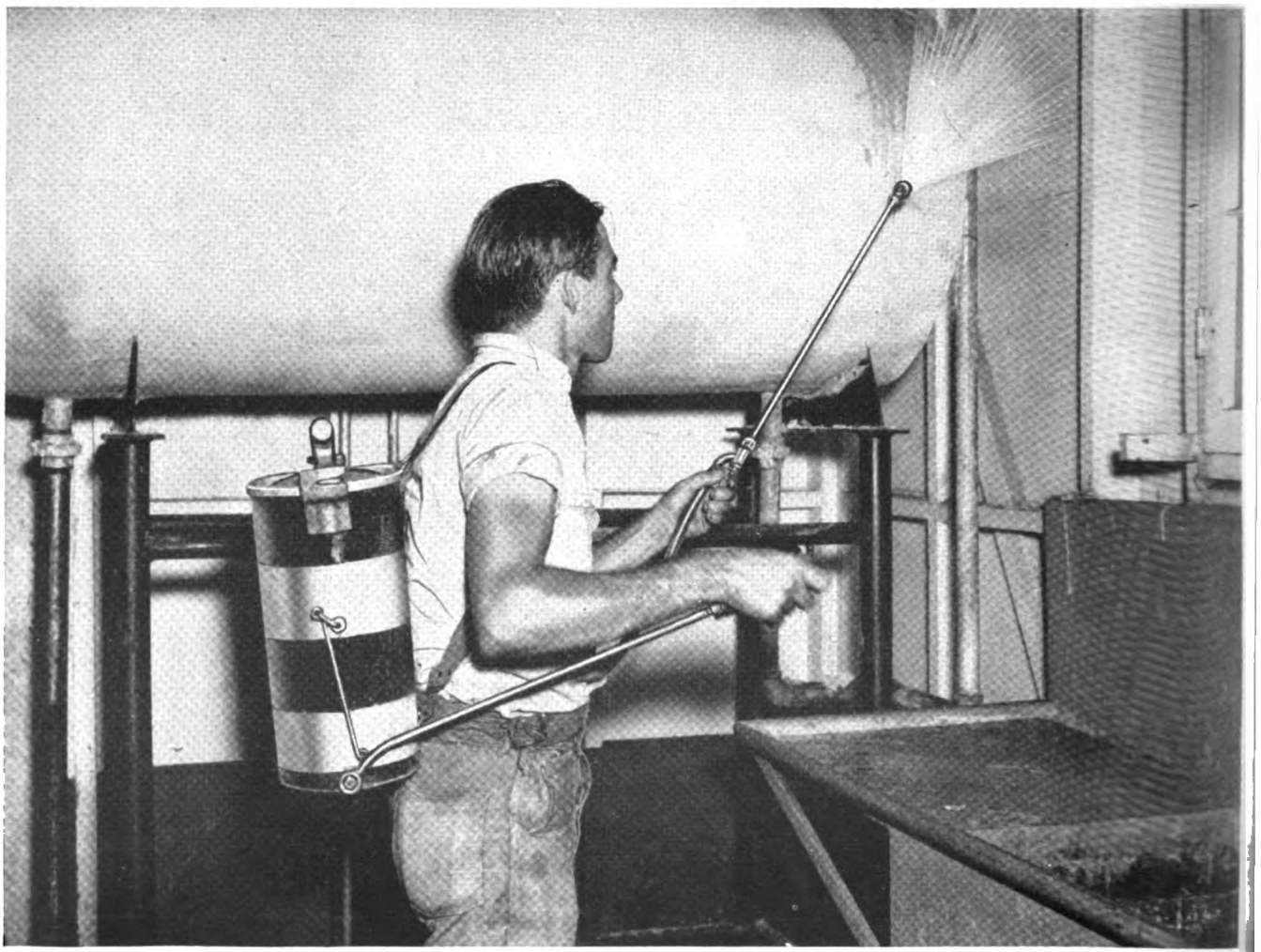
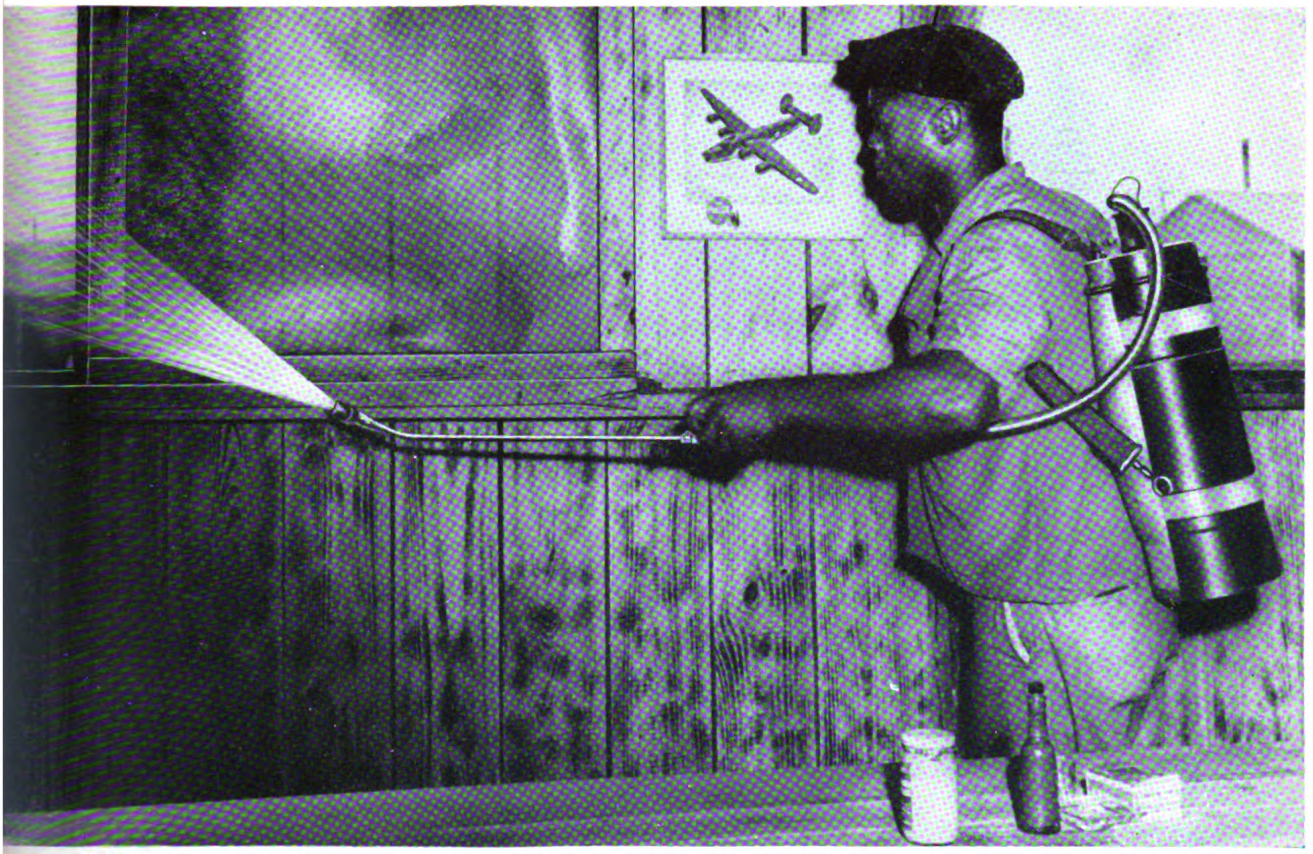
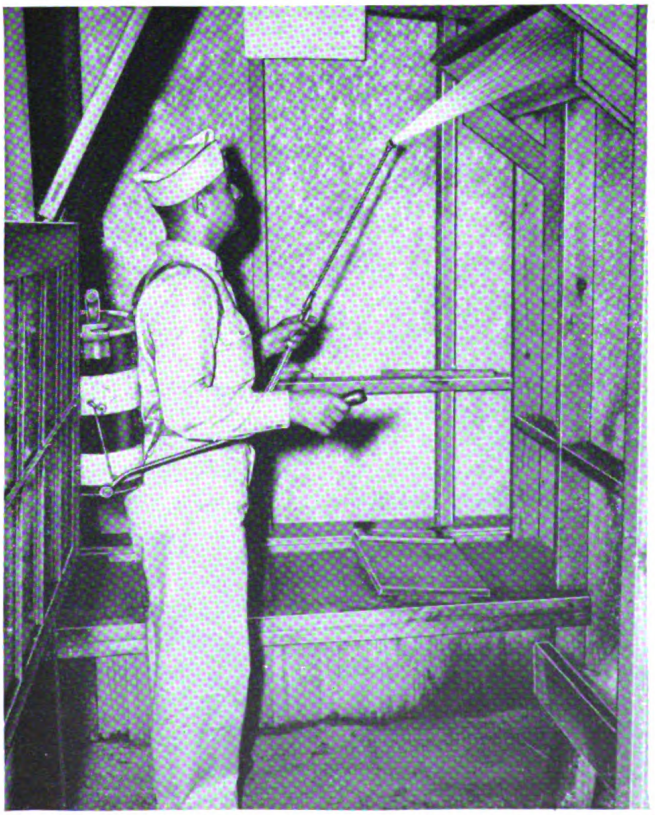


Figure 28. Walls, ceilings, doors, window screens, and drop cords on ceiling lights should be sprayed with 5 percent DDT-kerosene spray for fly control. (Use CE Knapsack Sprayer, Stock No. 41–7839.400.030.)



① *Screens treated with 5 percent DDT in kerosene.*



② *Ceilings, walls, and seats of pit latrines sprayed periodically during warm weather with 5 percent DDT in kerosene.* (*Use CE Knapsack Sprayer, Stock No. 41–7839.400.030.*)

Figure 29.

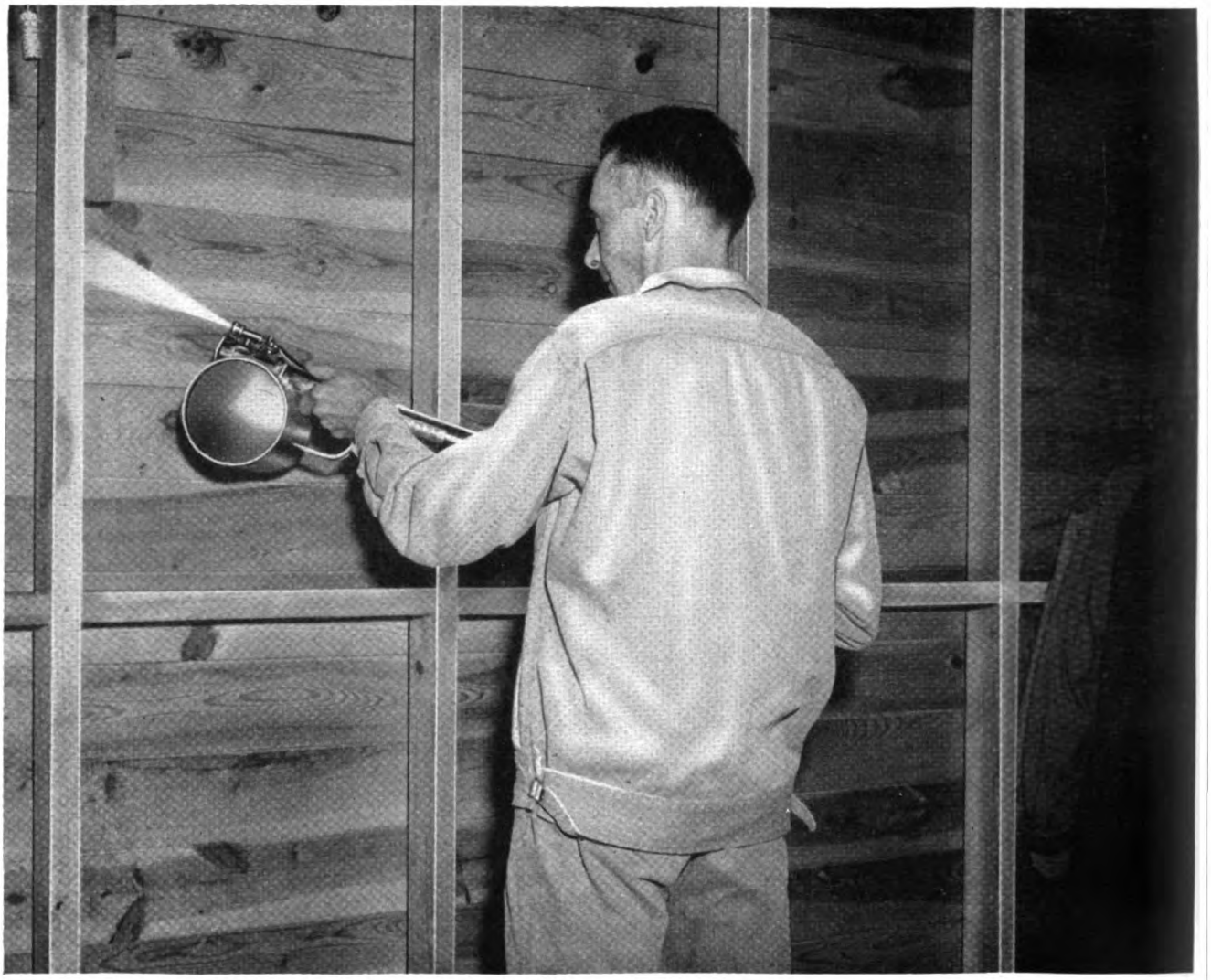


Figure 30. Hand spray equipment for DDT residue sprays.

e. Fly Traps (fig. 31). Properly constructed fly traps, baited with sweet, fermenting liquid bait, catch large numbers of flies. They are not recommended as adequate substitutes for removal of breeding sources or application of DDT sprays. These traps are supplied by the Corps of Engineers, stock No. 42–9225.300–100, or constructed by the post engineer in accordance with Corps of Engineers drawings No. D5998–1, fly trap, cylindrical type A–1, or No. D5999, fly trap, square type A–2.

25. Control of Stable Flies

a. Control of Breeding Places. The stable fly, or dogfly, closely resembles the housefly in appearance but is a biting species. It sometimes occurs in large numbers, especially in late summer and fall, but does not visit human food. The bites may seriously annoy man and animals. The stable fly breeds in fermenting accumulations of cured hay and straw exposed to the weather; in shore deposits or marine grasses and algae along bays, sounds, and inlets; or litter and strippings, following the harvest of peanuts, celery, onions, or other agricultural crops. Such materials ferment in damp places or in wet weather. Breeding in such locations may be controlled by dusting all deposits of rotting vegetation with DDT 10-percent dust, spraying with DDT 5-percent solution in oil, scattering and burying such vegetation, or by composting them and spraying or dusting with DDT. Spraying with a well-activated mixture containing one part creosote and three parts water, or with a solution containing 1.5 pounds of paris green, 8 pounds of hydrated lime, and 45 gallons of water is also effective.

b. Control of Adults. Adult stable flies may drift with the wind many miles from their breeding place. They are controlled by spraying building interiors as for houseflies. Control in bivouac areas has been secured by spraying tents, other shelters, and outside places where flies congregate.

Figure 31. Fly trap recommended for use at Army posts.

CHAPTER 4
GNATS AND OTHER DIPTERA

26. General

The term gnat is applied to a wide variety of small, two-winged, mosquitolike flies, many of which feed upon human and animal blood. (See fig. 32.) Gnats which are pests and carriers of disease include sandflies, blackflies or buffalo gnats, eye gnats, and some nonbiting species of midges.

27. Sandflies

Sandflies and punkies or "no-see-ums" are important chiefly because of the annoyance caused by their biting, although they have been found to carry sandfly fever as well as other diseases.

a. Characteristics. Sandflies are minute gnats, measuring only 1 to 3 millimeters in length. They are abundant along the Atlantic and Gulf coasts, while certain species are serious pests also in the central regions of California. The eggs of some species are laid on mud near water, and the slender wormlike larvae burrow in the mud or swim in the water. Breeding is heavy in fresh-water inlets, tide-water pools, water in tree holes, and even in decaying humus of densely shaded areas at the edges of grassy marshes and mangrove swamps; other species breed in damp crevices in rocks where humus material has collected. Only the female flies bite, being active at dusk or in shaded areas during the day. They may travel 2 or 3 miles from their breeding places.

b. Control. Post engineers may be required to execute control measures in areas where these pests interfere with training. Because of their small size, sandflies pass through most screens, although spraying screens and mosquito bars with DDT or an insect repellent is sometimes recommended.

Breeding places of these gnats are often difficult to eliminate. Drainage is of value, but the ground must be completely dried at frequent intervals because some of the young stages live in mud. Water-filled tree holes and crevices in rocks may be sprayed with 5 percent DDT in kerosene or cut away enough to drain out the water.

Better control is secured by repellents and repellent-treated clothing outdoors and by spraying 5 percent DDT in kerosene on screens and walls, under eaves, and in dark corners indoors. Because these gnats almost always alight on walls or screens before seeking the blood meal, use of DDT residual spray is effective.

28. Blackflies

a. Characteristics. Blackflies bite freely in the daytime and may swarm in large numbers in some training areas. They are small, stout, usually black, humpbacked in appearance, and have short antennae. They breed in swiftly flowing streams and may travel several miles from breeding places.

b. Control. Screening against blackflies is unnecessary because they seldom enter buildings. Where the insects attack personnel outdoors to create a nuisance, insect repellent or repellent-treated clothing is usually recommended. Gnat-proof clothing and veils may also be recommended under certain conditions. No practical means of preventing the breeding of blackflies is known although blackfly populations may be reduced by damming streams at intervals to reduce the areas where water tumbles over stones and logs. When outbreaks of blackflies occur, assistance of service command headquarters is requested for control recommendations.

29. Eye Gnats

a. Characteristics. Eye gnats are attracted to body secretions and feed on pus, blood, and excreta, presenting a threat in the spread of such infections as conjunctivitis. They have a strong liking for secretions of the eyes and nose and return quickly and persistently when brushed away. Eye gnats are minute in size and breed in such a wide variety of decaying vegetable and animal matter that control by elimination of breeding places is not ordinarily practicable.

b. Control. Eye gnats are trapped by specially designed bait traps placed in selected locations. (See fig. 33.) Traps are made of half-gallon tin cans with the top covered and several 1-inch open-

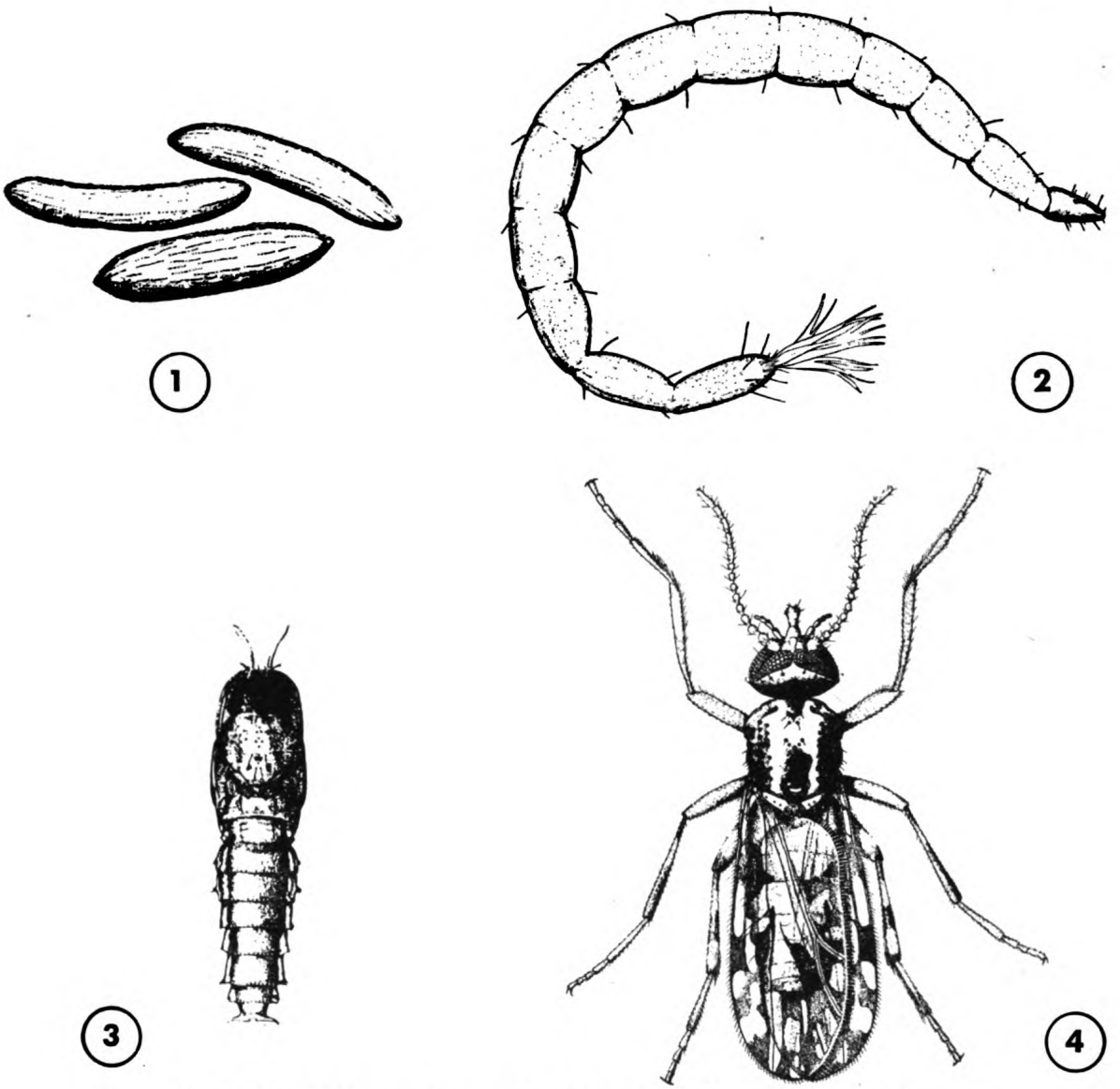


Figure 32. 1, Eggs; 2, larva; 3, pupa; 4, adult sandfly which is a minute biting midge.

ings cut near the bottom in such a way that the resulting flaps of metal turn up to shade the openings. The openings are covered with screen to keep out blowflies, yet permit entrance of the tiny eye gnats. A screw-top wide-mouth glass jar is attached at right angles over a larger opening in the side of the tin can near the top. Liver and water bait is placed in the bottom of the trap. The gnats enter through the screens to feed and then are attracted into the well-lighted trap jar at the top. Control indoors is the same as for sandflies. (See par. 27.)

30. Midges

Various nonbiting mosquitolike midges often become a nuisance, occurring in such numbers that they blunder into the eyes, nose, and mouth, or fall into food. They may ruin newly painted surfaces by sticking to the wet paint. These gnats usually originate in nearby bodies of standing water such as ponds and reservoirs. Control measures are difficult and if recommended should be carefully supervised. Use of DDT sprays on adult resting places around breeding areas reduces the numbers greatly.

31. Psychoda Flies

Psychoda flies breed in the floral slime on trickling filter beds and sometimes in raw sludge beds at sewage treatment plants. Larvae in filter beds may be controlled by flooding; but spraying adult

resting places, especially the outer rim of the bed, gives good results in reducing their number. DDT emulsion may be introduced intermittently at the rate of one part to 1,000,000 into the influent to the beds. These flies do not transmit disease and are important only as pests.

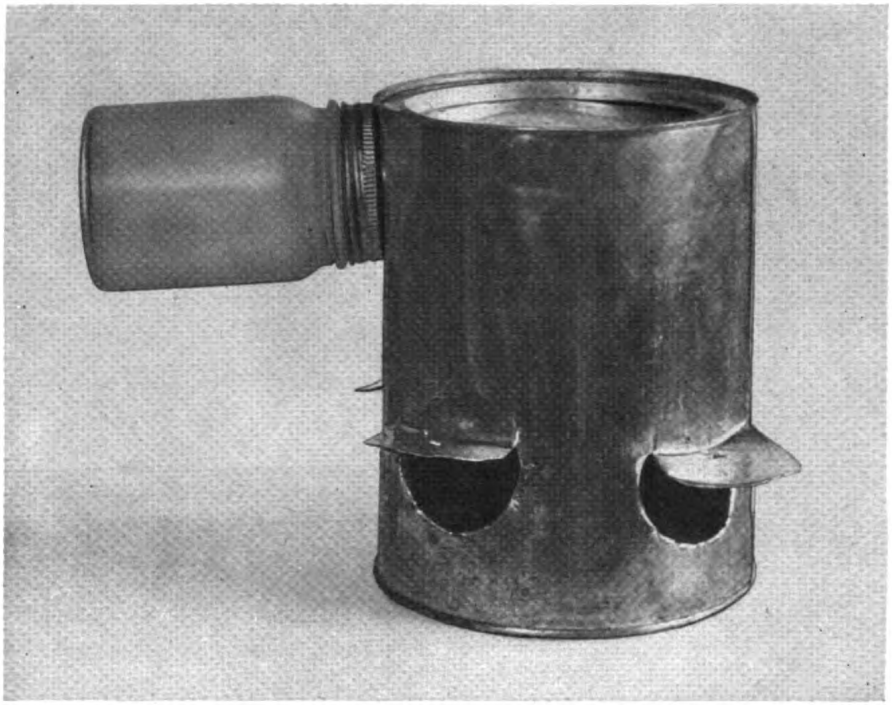


Figure 33. Trap baited with liver and water to catch eye gnats.

CHAPTER 5
BEDBUGS

32. General

The mature bedbug is a brown wingless insect about ¼ inch long. (See fig. 34.) It is a cosmopolitan pest that lives indoors in close association with man; its food is the blood of warm-blooded animals. The bugs normally feed at night but may feed during the day in darkened rooms. They are distributed in many ways: in luggage, infested beds and mattresses, or furniture moved from one building to another. They also distribute themselves by clinging to the clothing of persons in such places as overcrowded movies or busses, trains, and hotels. These insects develop from eggs laid in cracks in walls or other sheltered places affording protection and concealment. The bugs soon hatch and begin feeding and growing. Adults live from 6 to 8 months, and females lay as many as 500 eggs. The adults may survive without feeding for several months in unoccupied and unheated buildings. They are found on Army posts, hiding in the walls of barracks, on beds and mattresses (figs. 35 and 36), on theater seats, and in desks and furniture. Although heavy bedbug infestations are associated with unclean housing, barracks or other buildings kept spotlessly clean may still become infested.

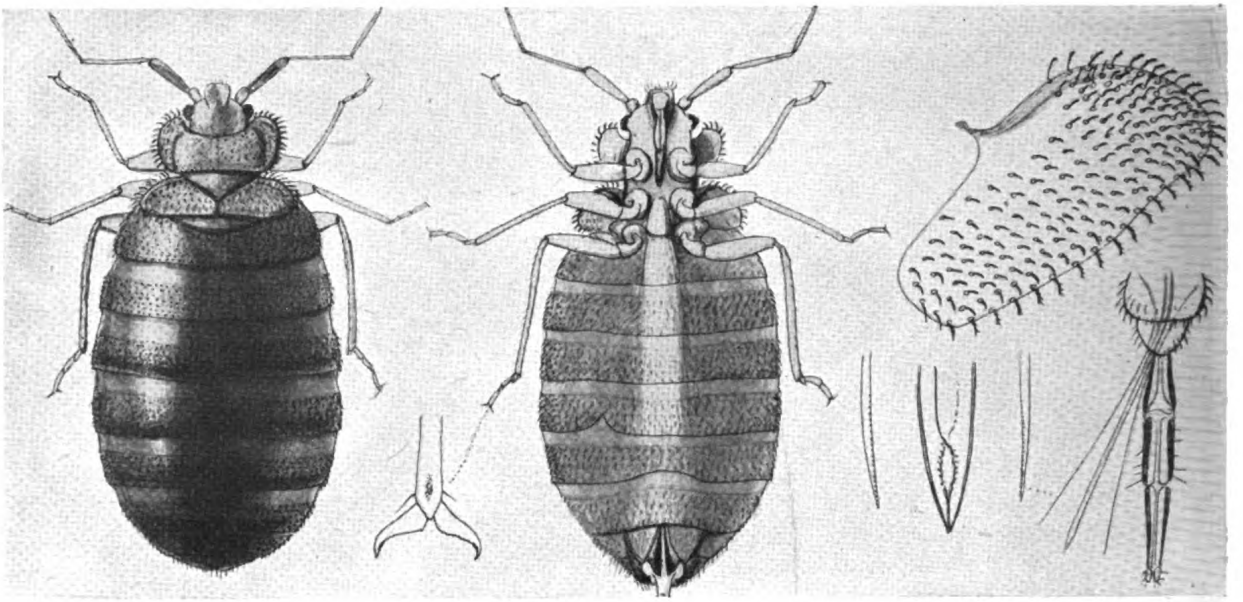
33. Control

Fumigation with hydrocyanic acid was formerly used for control of bedbugs on Army posts. However, DDT is safer, more effective, and recommended to replace hydrocyanic gas for this purpose.

a. Application of DDT (fig. 37). Spray with a 5 percent solution of DDT in kerosene (QM No. 51–I–305: Insecticide, spray, DDT, residual effect), obtaining complete coverage of beds, mattresses, and barracks walls to a height of about 6 feet from the floor. A residue of DDT remains on surfaces where they rest or over which they migrate in search of food. This process eradicates bedbugs from buildings and prevents their reestablishing themselves up to 1 year after treatment. About 3 gallons of 5 percent DDT spray in kerosene is required to spray effectively a 63-man barracks. Recommended dosage is 1 quart of spray for 250 square feet of wall space and 1 quart of spray to cover 5 beds and 5 mattresses. Avoid fogging by using a coarse spray. Hold spray nozzle 6 to 8 inches from surface treated.

b. Precaution for DDT. See paragraph 81.

c. Fumigation (fig. 38). If DDT is not available and fumigation is recommended, hydrocyanic acid discoids should be applied. This process is carried out only by trained and certified crews approved by service command headquarters. (See ch. 15.)



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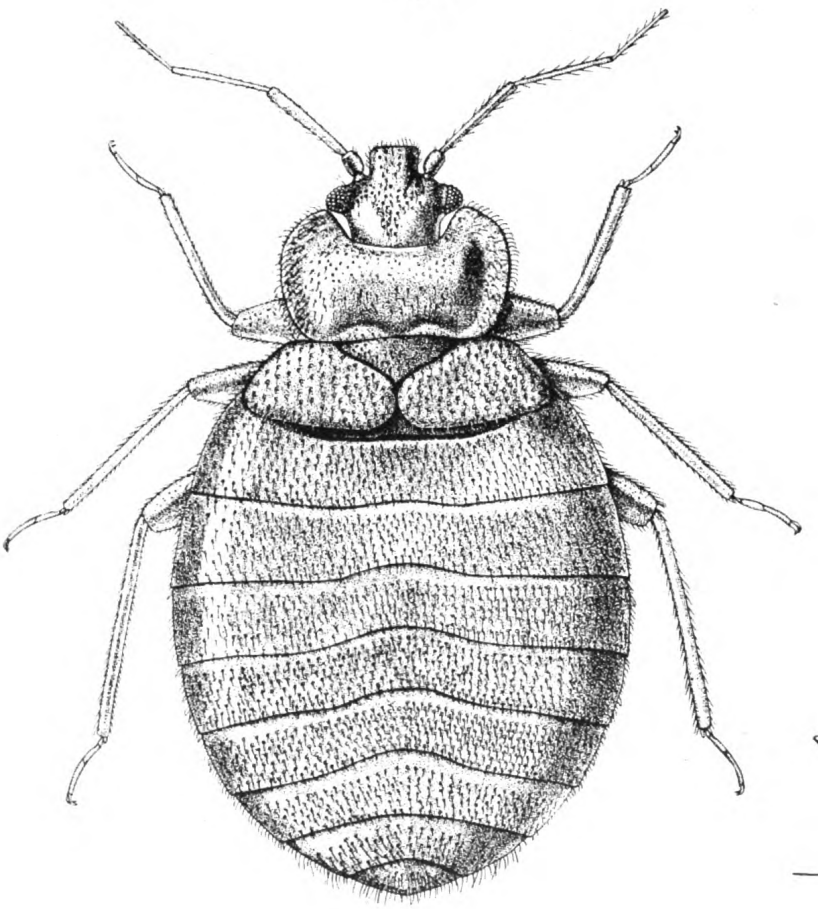

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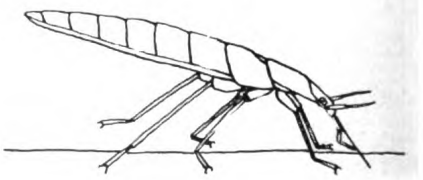

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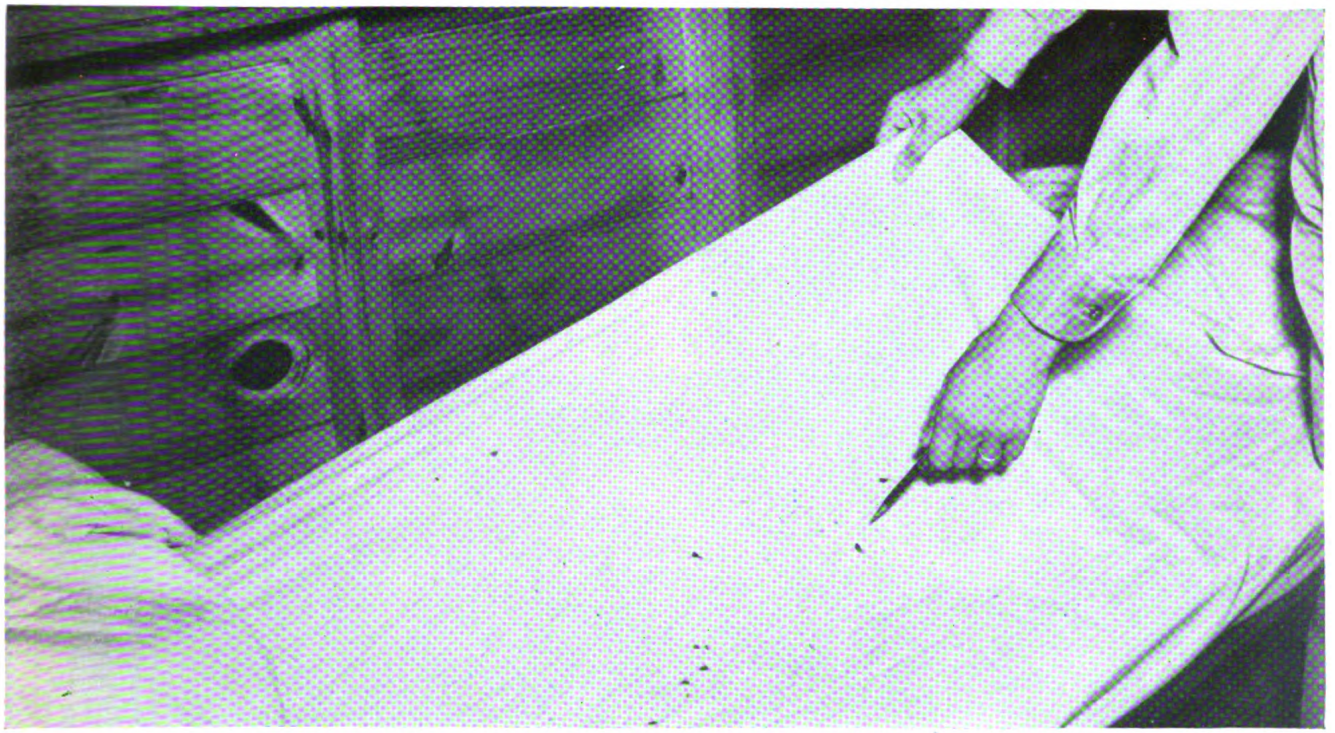
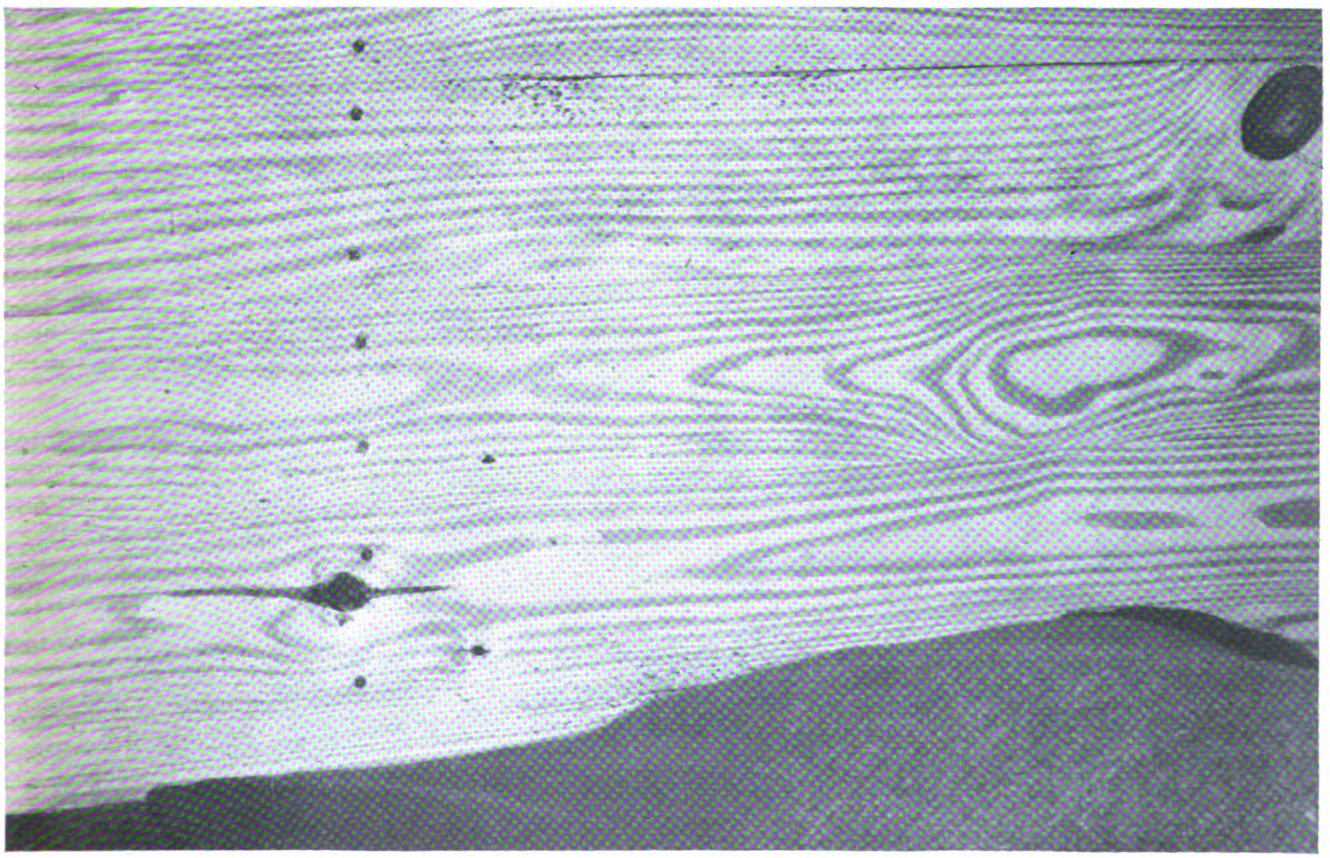
① *Dorsal and ventral view of engorged bedbug.* ② *Adult female bedbug.*
③ *Diagrammatic side view in position on skin assumed by insect during feeding.*

Figure 34.



① *Bloodstains on sheet as a result of feeding by bedbugs.*



② *Stains from excreta deposited by bedbugs on walls of barracks.*

Figure 35.

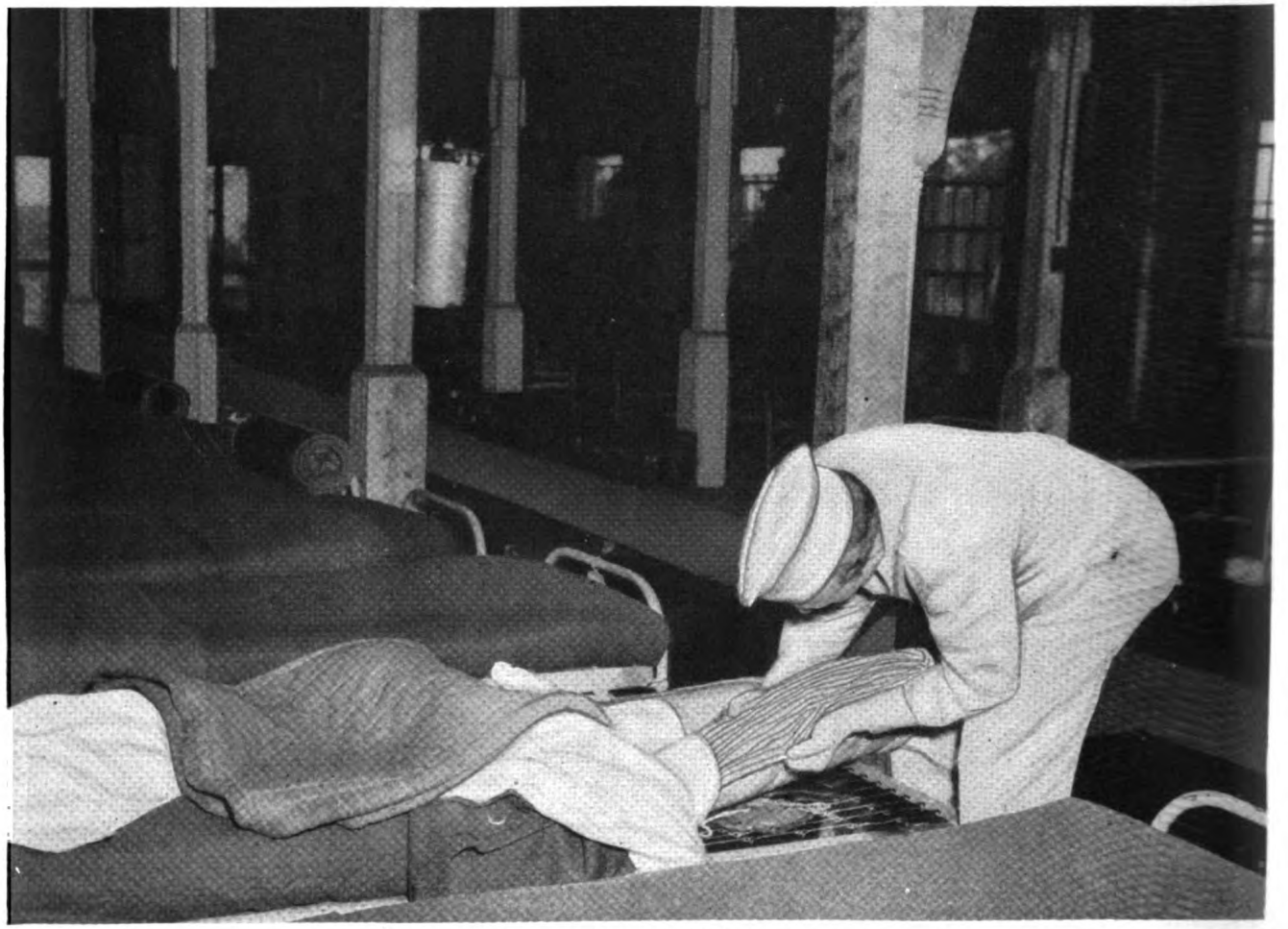
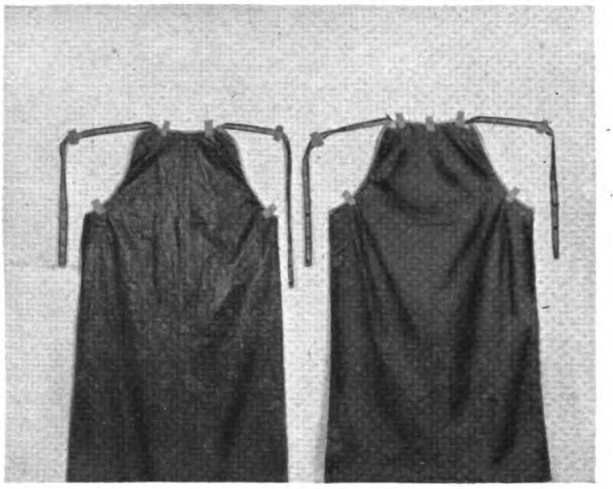


Figure 36. Bedbugs hide in rolled edge of mattress.

①



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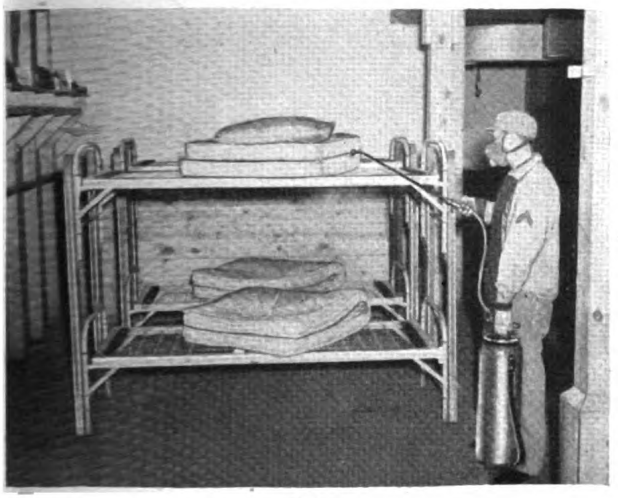

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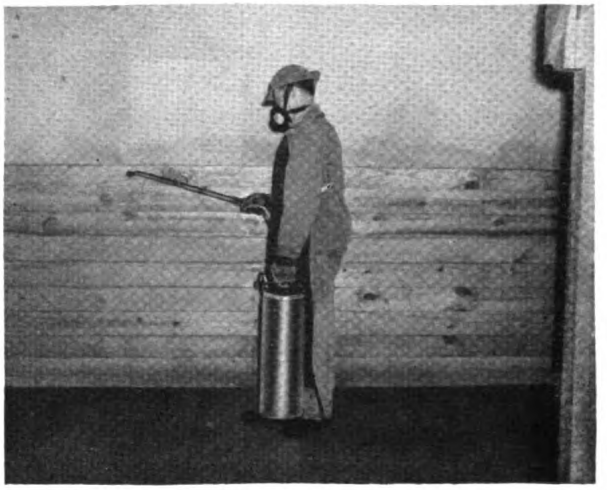

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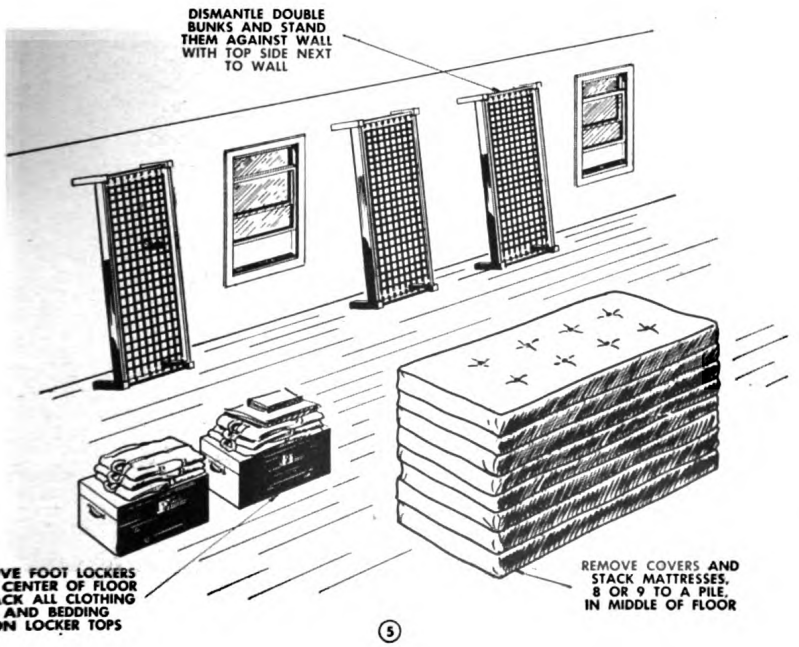


⑤

① *Application of 5 percent DDT spray for bedbug control.*

② *Aprons for protection of operator.*

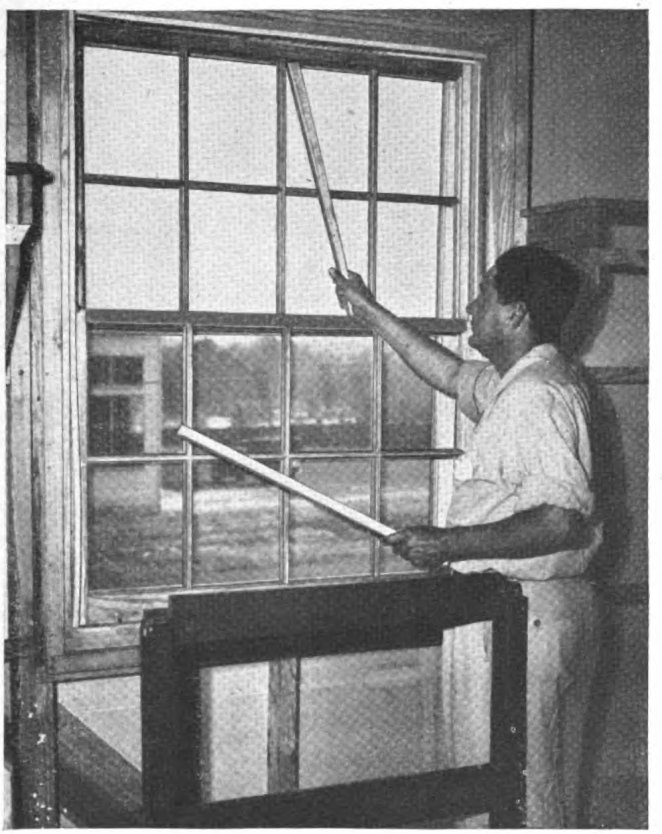
③ *Spraying beds in place.*

④ *Spraying walls.*

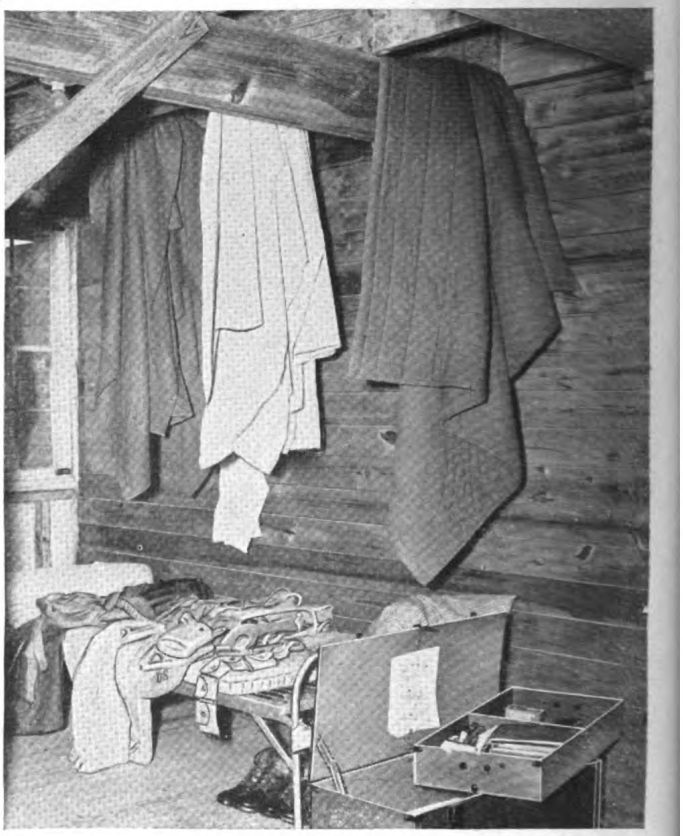
⑤ *Placement of beds against wall and stacking mattresses and clothing as an alternate method of spraying DDT for bedbug control.*

Figure 37.

① *Sealing windows of barracks prior to fumigation.*



② *Bracing windows of barracks prior to fumigation.*



③ *Arrangement of bedding and clothing for fumigation.*

Figure 38.

④ *Fumigation of barracks with hydrocyanic acid gas.*

Figure 38—Continued.

CHAPTER 6
LICE

34. General

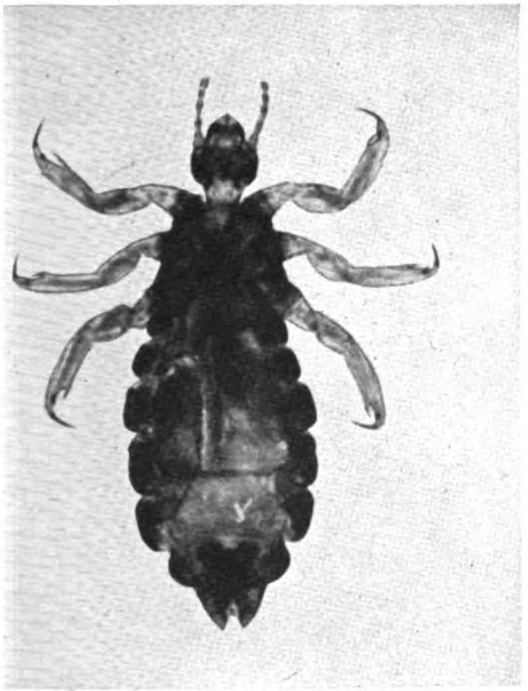
Lice are disease carriers and also annoy men who become infested. Infestations are more likely under crowded conditions, unless recommended precautions and control measures are taken. Lice that infest man feed by sucking blood. They transmit typhus fever, relapsing fever, and trench fever.

35. Characteristics

Three kinds of lice which infest man are body lice, head lice, and crab lice. (See fig. 39.) They multiply rapidly, are disseminated by contacts with infested individuals and clothing, and are seldom found far from the human host. They starve in a few days without food. Buildings or clothing usually do not remain infested for more than 7 to 10 days unless the lice have an opportunity to feed. The body louse confines its feeding to the body and remains chiefly on the clothing next to the skin. The head louse lives in the hair of the head, and the crab louse among the hair of the pubic region. The latter is also found on the legs, chest, armpit, and occasionally in the beard and eyebrows.

36. Control

Control includes delousing of the individual soldier and disinfestation of clothing, equipment, ships and other vehicles used by Army personnel and prisoners of war. (See fig. 40.) The Corps of Engineers cooperates in designing and installing delousing apparatus and fumigation apparatus; the Quartermaster Corps procures the equipment. The Corps of Engineers assists in the operation and maintenance of delousing and fumigation apparatus. Prevention and control of lice are discussed in TB MED 184 and 194.



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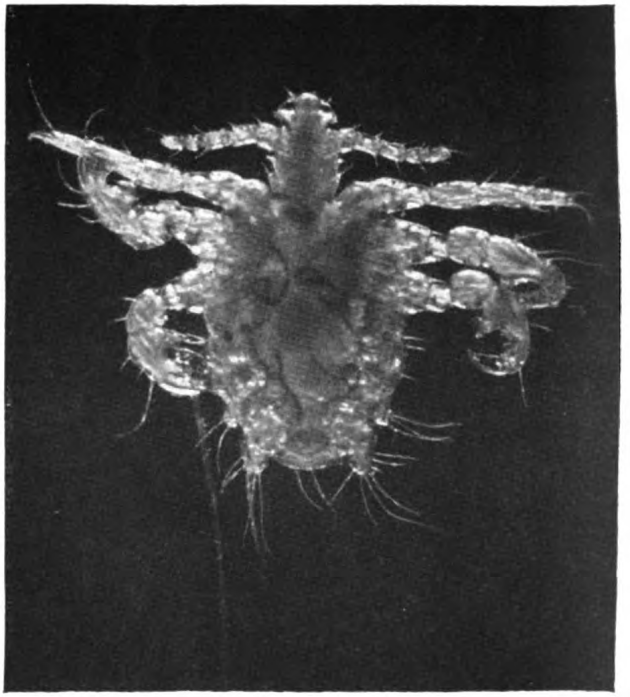

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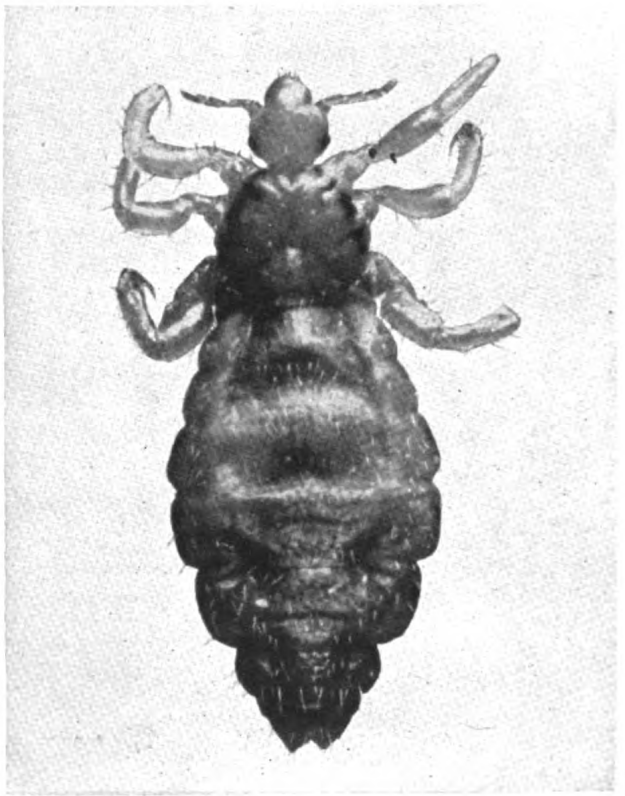

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① *Body louse, adult female.*

② *Head louse, adult female.*

③ *Crab louse, adult male.*

Figure 39.

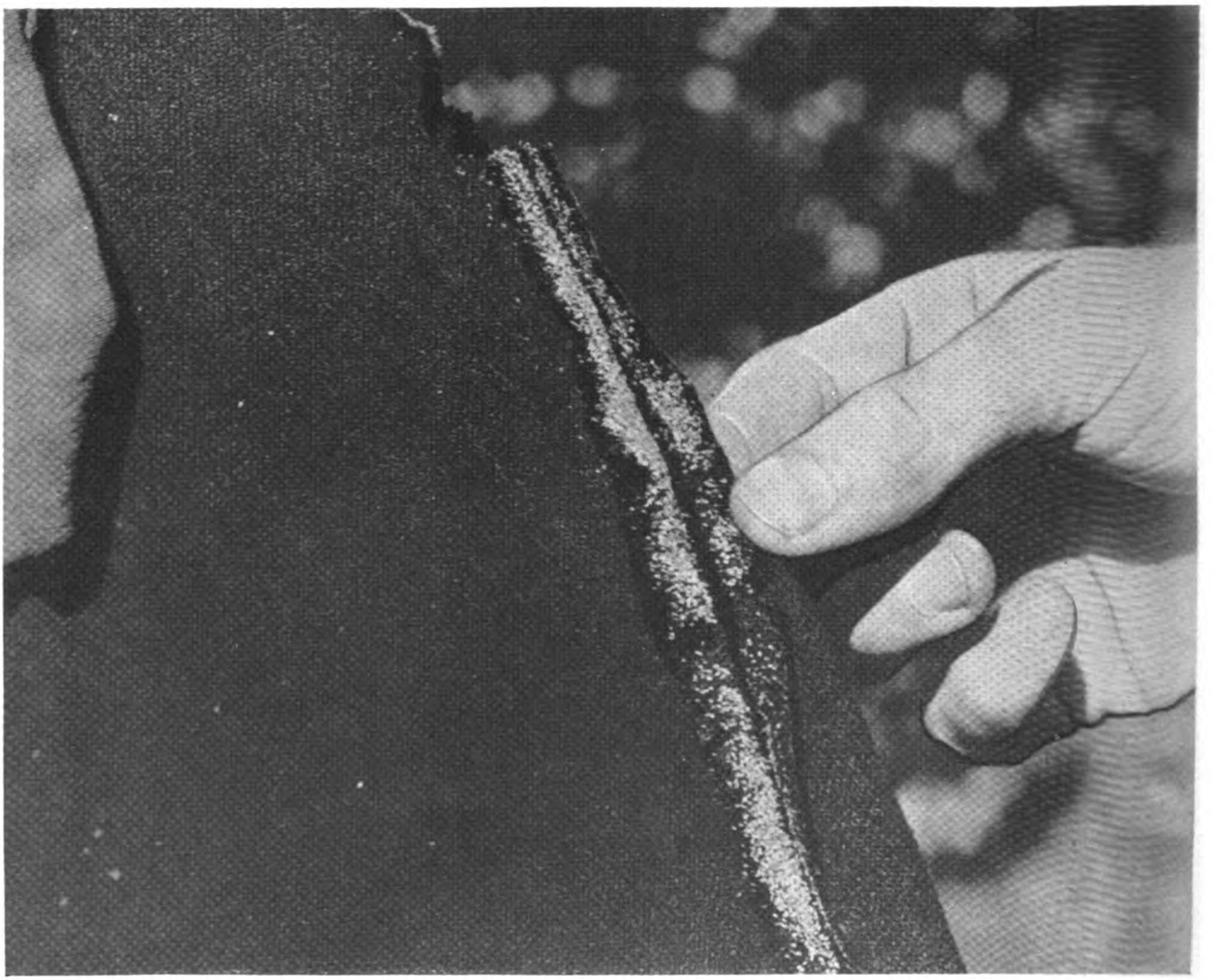
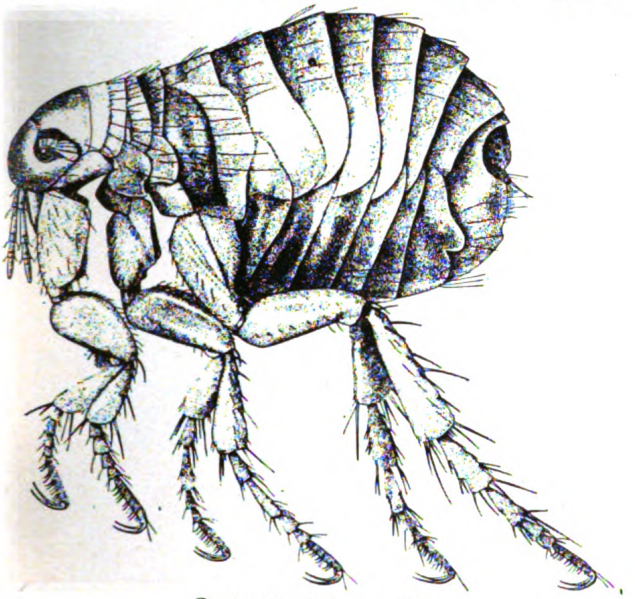


Figure 40. Eggs of body louse as deposited along seam of trousers.

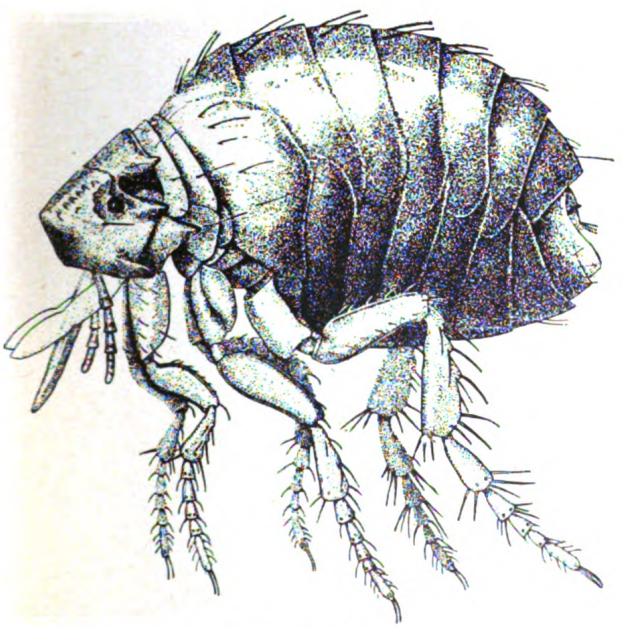
CHAPTER 7
FLEAS

37. General

In addition to being annoying pests, fleas are vectors of bubonic plague and endemic typhus fever. (See figs. 41 and 42.) Several animals, including rodents, serve as reservoirs of infection for these diseases. Found on dogs, cats, and rats, these insects may transfer to man whenever he comes into close association with the animal hosts. Eggs of fleas are laid in the fur of the animal host and drop off to lodge in sleeping quarters of the animals, in cracks in the floor, and on the ground outdoors. The eggs hatch in a few days in warm weather into small wormlike larvae that subsist on debris containing organic matter and become adult fleas in 14 to 21 days. The adults feed voraciously on the human or other animal hosts in and around infested buildings. The adults may survive for several weeks without food in vacant buildings attacking in

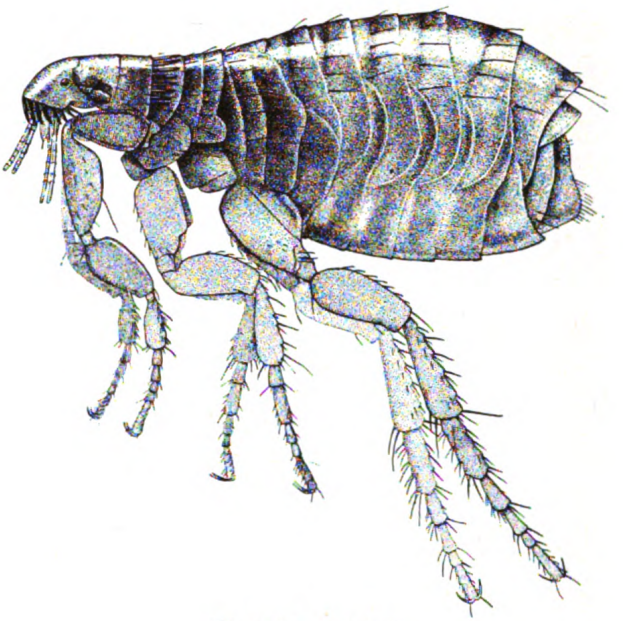


① *Adult, human flea.*



② *Sticktight flea.*

Figure 41.



③ *Adult cat flea.*

Figure 41—Conitnued.

Figure 42. Larva of flea.

large numbers when the buildings are reoccupied. Fleas breed in the nests and burrows of rodents.

38. Control

Control of fleas includes eliminating rodents or other wild animal hosts, disinfesting domestic cats and dogs, and treating breeding areas.

a. Eliminating Rodents. Rat control for prevention of disease is done in accordance with the recommendations of the Medical Department. This includes trapping, poisoning, ratproofing buildings, and fumigation. Details of recommended control measures are given in chapter 11. Rat burrows and runs should be dusted with 10 percent DDT dust to prevent fleas leaving the dead rats and transferring to humans.

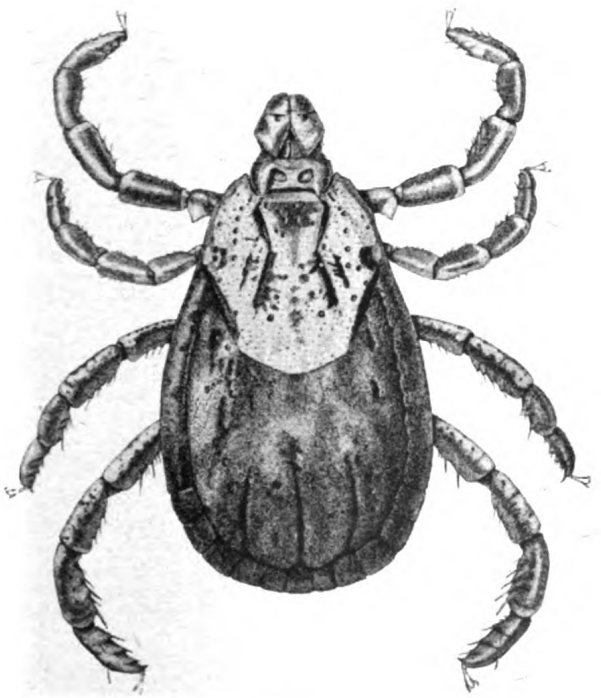
b. Disinfesting Cats and Dogs. Stray cats and dogs may be an important source of flea infestation on Army posts and should be eliminated. Pet animals should be kept out of barracks, offices, and storage warehouses. When disinfestation is recommended, treatment is made with small quantities of 10 percent DDT dust (QM stock No. 51–I–180: insecticide, powder, louse) rubbed into the fur.

c. Treating Breeding Areas. In treating breeding areas, the source of infestation is found and eggs and larvae are destroyed in sleeping quarters of animals, on floors of buildings, and in the burrows of rodents. Areas likely to be infested (barracks, warehouses, basements, outbuildings, dog kennels, theaters, recreation halls, grassed fields, lawns, and ground under buildings) should be sprayed with 5 percent DDT in kerosene. Spray is applied to floors and wall surfaces to 2 feet from the floor at the rate of 1 quart of spray for each 250 square feet. In infested living quarters, spray is applied to beds and mattresses at the rate of 1 quart for each 5 beds and mattresses. On earthen floors and underneath buildings, the dosage should be increased to about 2 quarts for each 250 square feet. Spray apparatus used for fly and bedbug control is satisfactory for control of fleas. Treatment of grassy areas may be done most effectively by dusting with 10 percent DDT dust from a rotary hand duster.

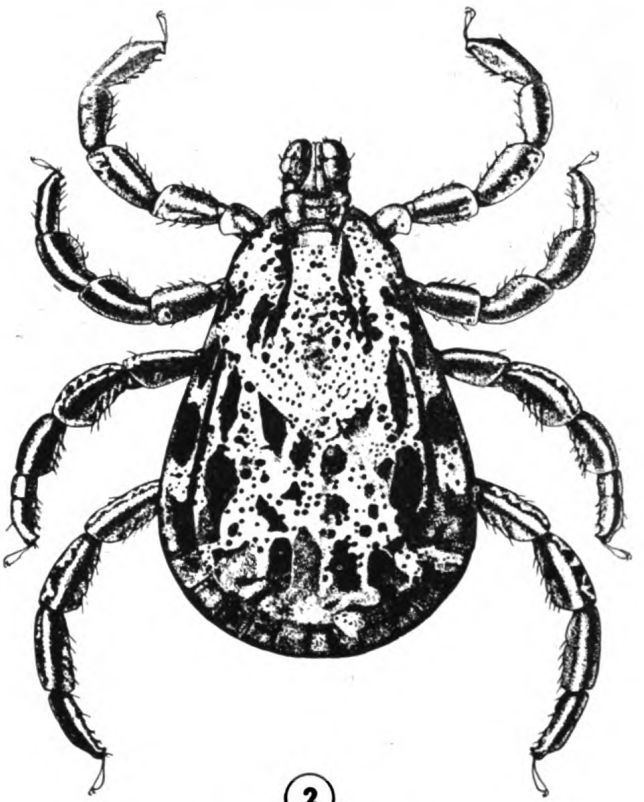
CHAPTER 8
TICKS

39. General

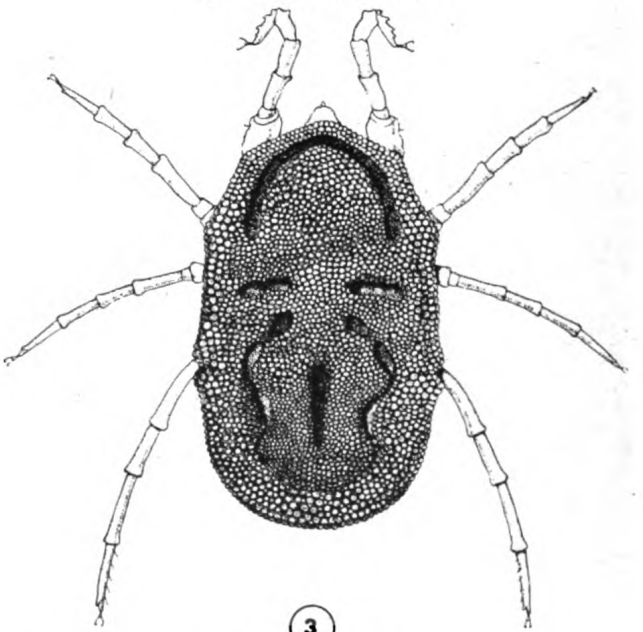
Ticks feed on the blood of man and animals after attaching themselves firmly to the skin of the host. The common wood tick is the most important species in the United States because it is the vector of Rocky Mountain spotted fever and tularemia. The rabbit tick and the American dog tick (fig. 43) are also important disease carriers and pests. These and other species of ticks may occur on Army reservations in sufficient numbers for the



① *Male and female dog ticks.*



② *Common wood tick.*



③ *Relapsing fever tick.*

Figure 43.

Medical Department to request assistance of the post engineer in carrying out control measures.

40. Characteristics

Tick stages include the egg, seed tick or larva, nymph, and adult. Ticks are usually long-lived, the adult living for as long as 5 years without food in the absence of a suitable host. They are widespread, and the prevalence of Rocky Mountain spotted fever is closely correlated with tick abundance. In most species, the blood-engorged seed ticks and nymphs drop from the host to the ground to molt in sheltered places. Adult females drop to deposit eggs, which hatch into seed ticks and attach themselves to another host animal at the first opportunity. (See fig. 44.) Troops on maneuvers or in bivouac may be severely attacked in tick-infested areas.

41. Control

Control of ticks may include the control of tick-infested animals, removal of infested vegetation from training grounds, insecticidal treatment of outdoor areas, wearing of protective clothing, use of repellents, and control of indoor infestations.

a. Tick-Infested Animals. Rodent control is an important part of any recommended tick-control program. These small, wild-animal hosts include rats, chipmunks, ground squirrels, meadow mice, and other rodents on which immature ticks may develop in large numbers. (See ch. 11.) Ticks on dogs may be controlled by sponging with a water suspension of derris, or with diluted rotenone extract, or dusting with 10 percent DDT powder. Applications of DDT dust have not proven highly effective for ticks.

b. Tick-Infested Vegetation. Seed ticks crawl up on weeds, grasses, and shrubbery to await human or animal hosts. They may attach themselves to the clothing of soldiers, finding their way to the skin for a blood meal. Clearing vegetation from infested areas reduces tick prevalence and is often recommended for training grounds.

c. Chemical Treatment of Outdoor Areas. Ticks are not insects and DDT preparations have not been found to be highly effective. Application of any recommended treatment to outdoor areas should have proper technical supervision. Sprays for outdoor areas containing nicotine sulfate and sodium arsenite are sometimes recommended. Each case must receive supervision regarding spray formulas, dosage rates, and apparatus for making field applications.

d. Treatment of Buildings. Spraying walls and furniture with 5 percent DDT solution in kerosene destroys immature ticks after 24 hours. The material is applied as for flies, mosquitoes, and bedbugs, but the kerosene used must be sufficiently refined to avoid staining after evaporation. Nothing that is tinted with oil-soluble dyes, such as certain wallpapers, may be wetted with kerosene.

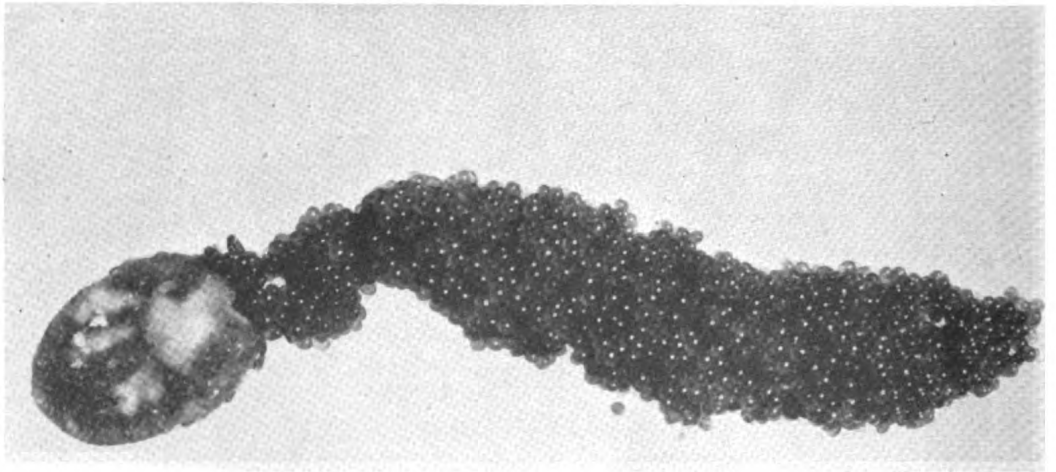


Figure 44. Female dog tick with eggs being deposited.

CHAPTER 9
CHIGGERS (MITES)

42. General

Chiggers, also called red bugs and harvest mites, are small mites that cause discomfort and annoyance to troops in bivouac areas, staging areas, and training grounds where they are present in large numbers. Chiggers attach themselves to the skin and their bites are often accompanied by a reddened swelling of the skin within 12 to 24 hours. (See fig. 45). Intense itching may persist for several days. Where heavy infestations require control measures, the post engineer may be called upon to carry out the work.

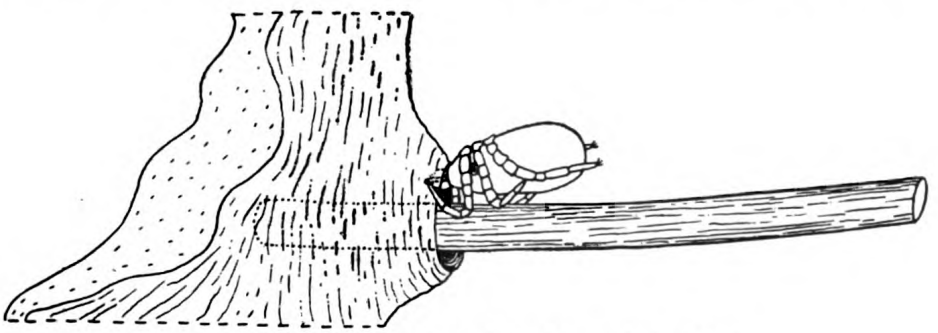


Figure 45. Chigger attached to skin at hair follicle.

43. Characteristics

Chiggers are blood-sucking parasites whose hosts include man, small rodents, rabbits, and many other animals. They are usually found on the ground on low vegetation and may severely attack the ankles, legs, and other parts of the body. Areas overgrown with weeds, briers, and brush provide a favorable environment. Although heaviest infestations in the United States are found in the southern States, the pest may occur as far north as Minnesota and locally along the Atlantic Coast to Cape Cod.

Larval mites transmit scrub typhus. The prevention of this disease is a problem of increasing importance in the Southwest Pacific and in Southeast Asia.

44. Control

Control of chiggers may include recommendations for removal of vegetation from infested areas, chemical treatment of training grounds, wearing of protective clothing, and use of insect repellants.

a. Clearing Vegetation From Infested Areas. Chigger infestation can be reduced or eliminated by clearing and burning underbrush and keeping weeds and grass cut. These clearing operations are usually extended 50 to 100 feet from the grounds to be protected. When this method of chigger control is recommended, the work should be coordinated with the ground unit maintaining vegetated areas.

b. Chemical Treatments of Training Grounds. Application of insecticides to the soil and vegetation of infested areas is not generally recommended. Some degree of protection is reported however from the application of 325-mesh sulfur, a treatment that should supplement brush removal and the cutting of weeds and grass. The sulfur dosage recommended is 50 pounds an acre applied with a rotary hand-operated duster. Applications are made at intervals of about 2 weeks until chiggers are brought under control. Technical supervision should be provided for all chemical treatments.

c. Impregnation of Clothing. Protection is afforded to individuals by wearing garments impregnated with the insect repellent Dimethyl phthalate. Details of this clothing treatment are given in TB MED 121. Garments treated according to directions will remain miteproof for 5 weeks of occasional wearing or until laundering is necessary under ordinary field conditions.

CHAPTER 10
TERMITES

45. General

Maintenance costs for wood buildings or masonry buildings containing wood are greatly increased if termites are allowed to develop destructive populations. (See fig. 46.) Army supplies and property in such storage are also likely to be destroyed by these pests. Most of the damage is caused by the subterranean or ground-nesting termites, which do millions of dollars of damage annually in the United States. Effective control measures must be taken promptly when infestations are revealed, and effective preventive programs should be maintained for new construction. Losses become unnecessarily high, materials and manpower are wasted, and a preventable burden is placed on those responsible for the post's operation when termites are uncontrolled.

46. Characteristics

Subterranean termite colonies occur in soil where ample moisture is present. The colonies develop and thrive where wood has contact with the ground. Once established, termites construct mud shelter tubes leading from the nest, over the surface of any building material, through cracks, joints, or other openings to reach wood for food.

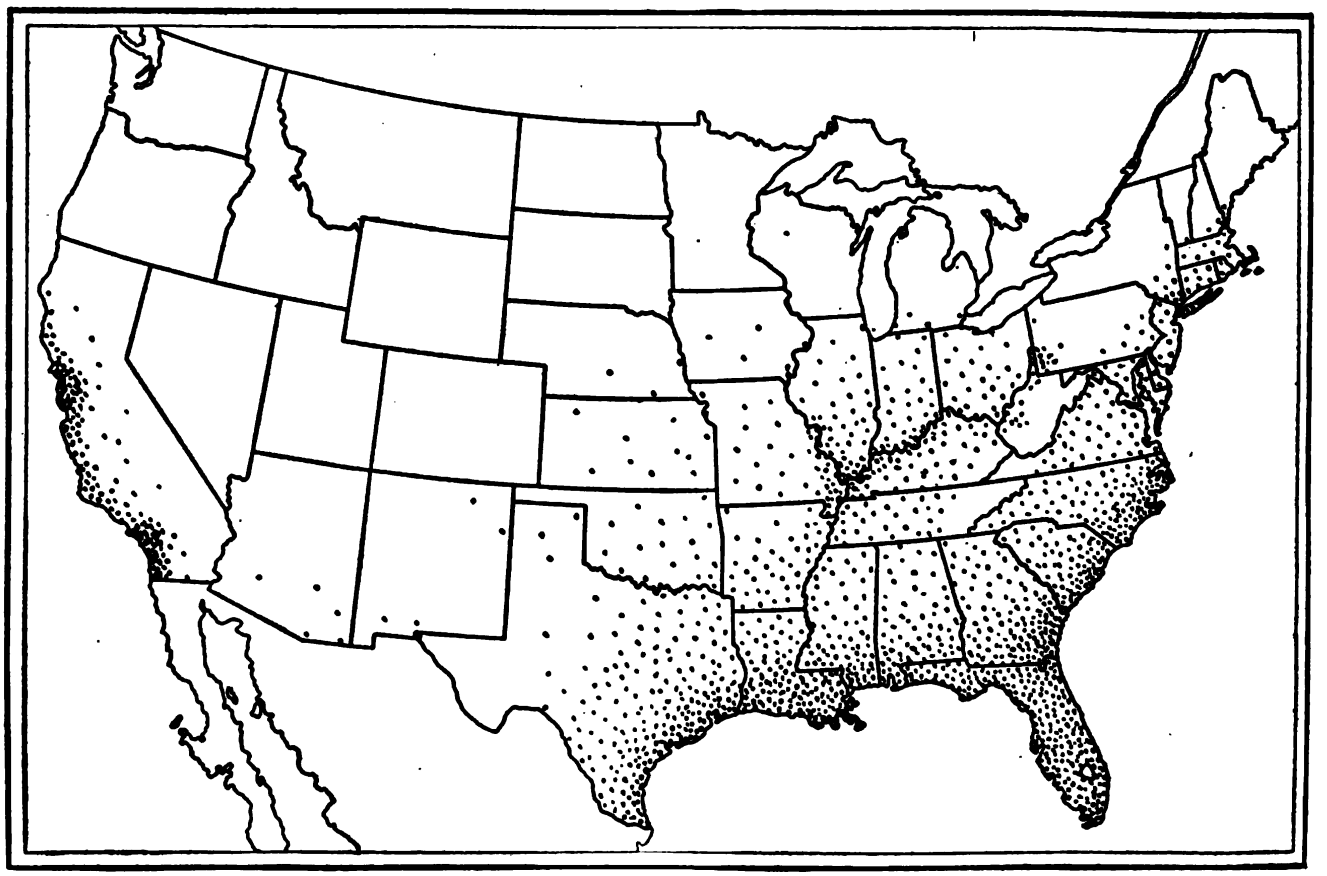


Figure 46. Map showing, by density of stippling, the relative hazard of termite infestations. They occur to some degree in every State.

(See fig. 47.) When these tunnels appear on exterior surfaces, detection is not difficult, but the tubes may enter the wood from below through brick or hollow tile, leaving no external evidence of the passage.

Termite colonies contain three forms or castes; workers, soldiers, and reproductive forms. (See fig. 48.) The workers are small, soft-bodied insects, grayish white in color, and without wings. The soldiers are similar in general appearance to the workers but have large brownish heads and pincerlike jaws. The reproductive forms have brown or black bodies and two pairs of wings.

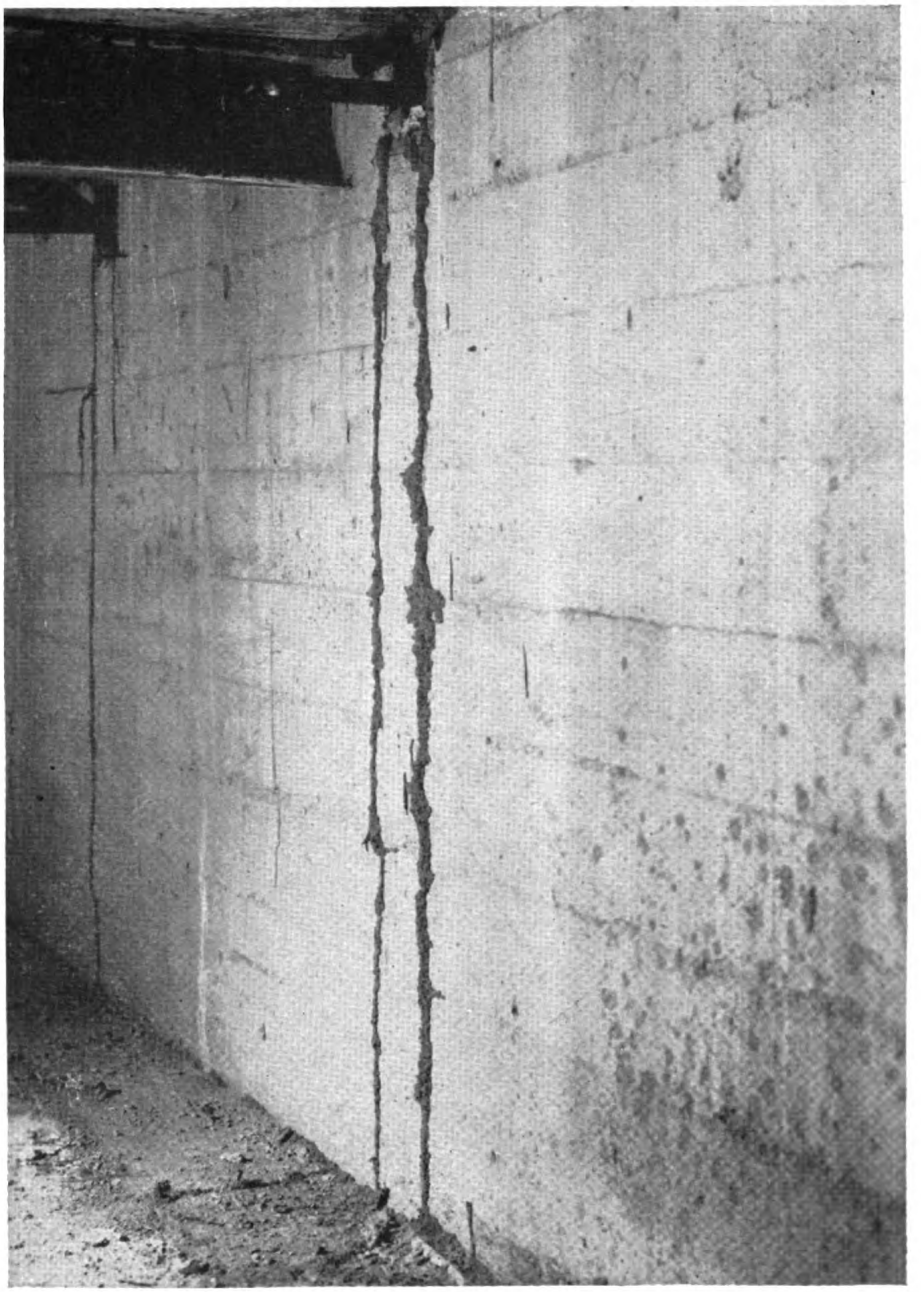


Figure 47. Termite shelter tubes extending along poured concrete wall, connecting wood of building with soil.

47. Inspections

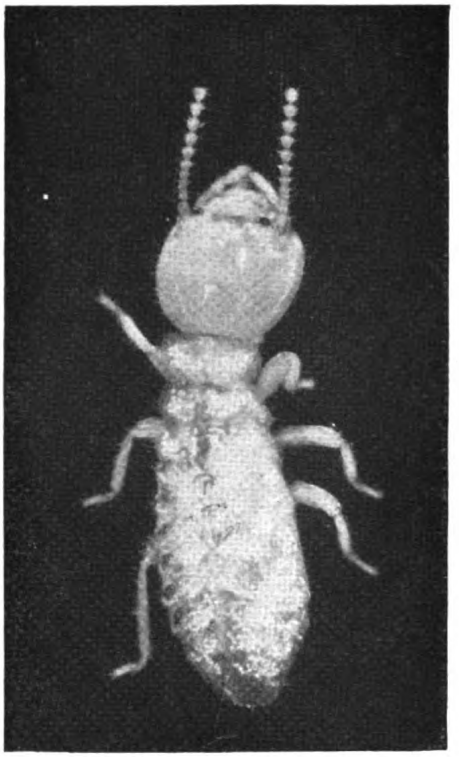
Buildings and other structures of a permanent character should be inspected annually for termite infestations. The flight of winged reproductive termites marked by the presence of discarded wings is evidence that an established colony is located nearby. (See fig. 49.) These winged forms are often found beneath doors or windows inside buildings where the insects have emerged and were unable to escape. In addition to the winged termites, signs of termite work and damage may be found on form boards, grade stakes, tree roots, stumps, or other wood having contact with the soil beneath or near buildings, foundation surfaces of buildings, wood porches and steps, door frames, foundation piers, partitions and bins, basement walls, wood floors over concrete, girders, sills, joints below grade, water pipes, and conduits. (See figs. 50, 51, and 52.)

48. Control

a. General Measures. Recommendations for control of termites in existing buildings are generally as follows:

(1) Remove all such wood scraps and waste as boards, stakes, stumps, and chips from the ground surface under and around buildings.

(2) Grade areas in and around buildings to



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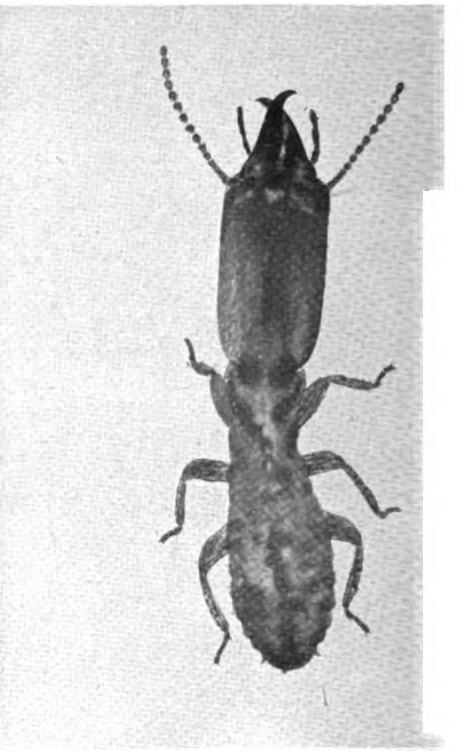

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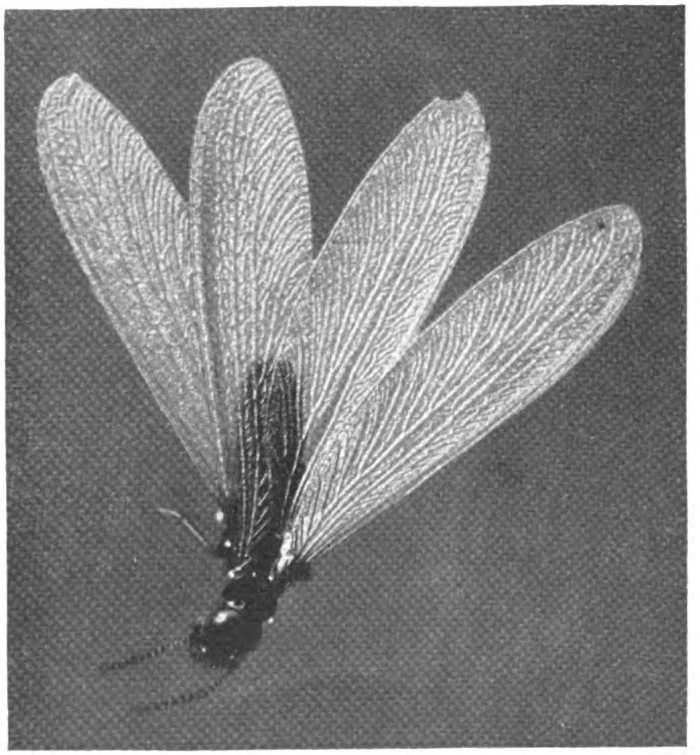

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① *Adult worker termite.* ② *Adult soldier termite.* ③ *Winged adult reproductive termite.*

Figure 48.

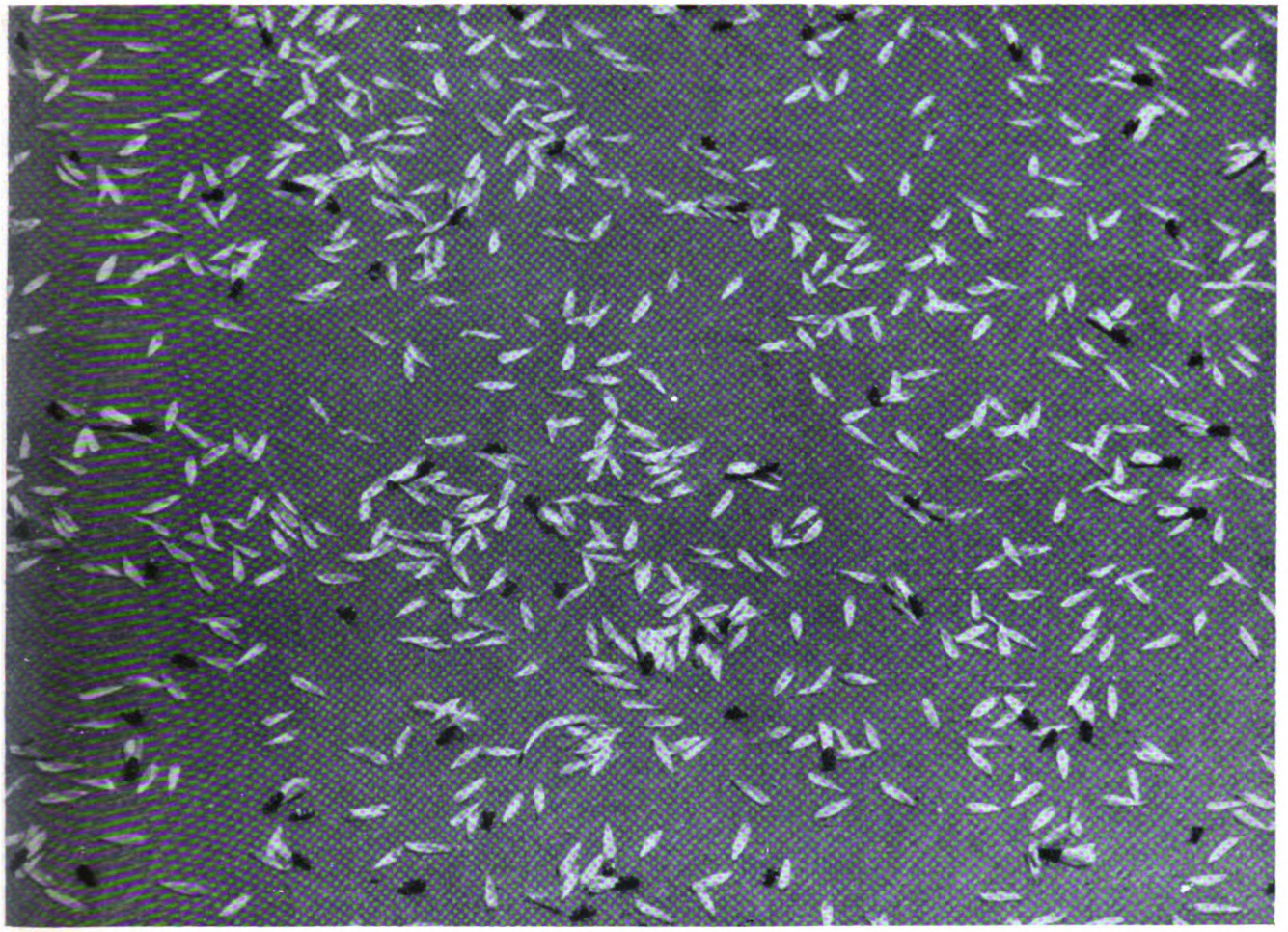


Figure 49. Winged reproductive termites, called kings and queens, and discarded wings.

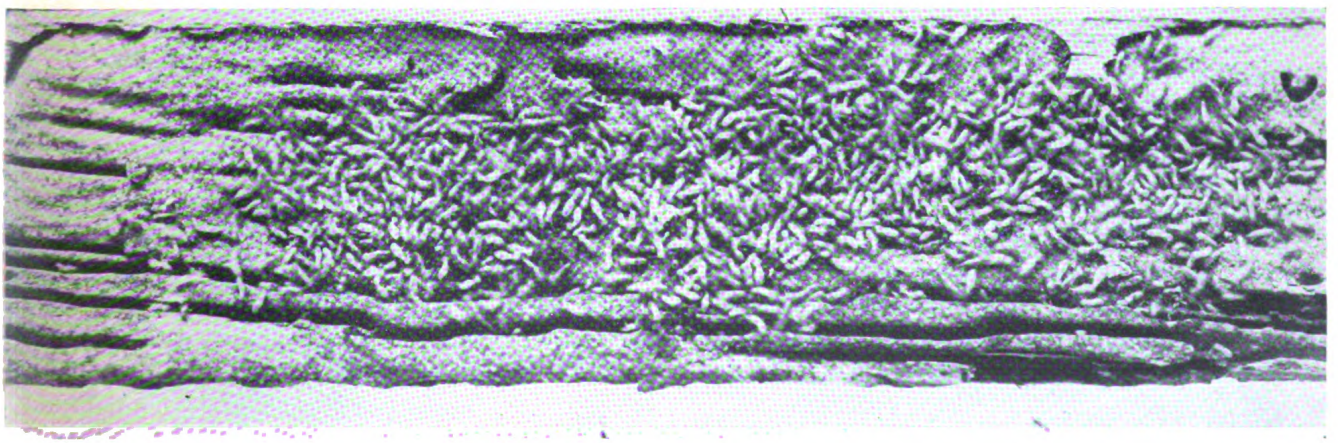


Figure 50. Termites exposed upon removal of surface layer of infested wood.

Figure 51. Termite damage to overhead joist header.

drain water away from the foundations and keep soil as dry as possible.

(3) Prevent wood decay in corners of building foundations and provide sufficient air circulation and cross ventilation beneath wood construction. Make ventilation openings not less than 0.5 percent of floor area plus ½ square foot for each 25 lineal feet of exterior wall. (See fig. 53.) Provide space for making periodic inspections.

(4) Whenever practicable or when doing repair work, elevate steps upon concrete footings so wood comes not closer than 3 to 6 inches from the ground.

b. Skirting. For buildings having skirtings, a clearance between skirting and ground of 3 to 6 inches is recommended in summer so termites cannot bridge the gap. In winter, both ventilation openings and this clearance are frequently closed to insure floor warmth, the latter usually being done by banking dirt to skirting. The desired minimum clearance of 3 to 6 inches should be reestablished early each summer.

(1) Whenever skirting has been installed across the face of building piers without maintaining the 3-inch minimum clearance from the pier, it should be relocated whenever possible.

(2) If metal shields have been installed, the skirting must clear the metal by 2 inches. (See cantonment type building, plan 700–1163.)

c. Miscellaneous Appendages. All miscellaneous building appendages such as coal bins, wood steps, and fire-escape ladders should be installed with a minimum unbridged clearance of 2 inches from the building proper.

(1) When coal bins are built on concrete platforms, at least 6 inches of exposed concrete should

Figure 52. Termite shelter tubes between soil and wood or floor.

be maintained along the edge above ground or along top concrete surface to edge of wood bin.

(2) When wood steps and ladders have been placed in contact with the ground, they should be separated from the building at the first opportunity and set on concrete bases. (See fig. 54.)

d. Metal Shields (fig. 55). Metal shields, frequently installed on Army buildings to protect against termites, must be maintained properly. Joints and angles should not be broken, nor should shields be bent or injured in any way. If metal termite shields were omitted during construction, they need not be added unless recommended by the service command headquarters. Many design features have been adopted for cantonment type buildings that obviate the need for termite shields. (See cantonment type building details, plan No. 700–1163.)

e. Destruction of Termite Colonies. Direct methods for destruction of termite colonies must be carried out.

(1) Break contact of wood with the soil by destroying shelter tubes. Keep the contact broken.

(2) Use treated wood near the ground (Federal specification T–T–W–571b).

(3) Apply soil poisons around building foundations in accordance with recommendations of service command headquarters. Among poisons available are sodium arsenite, DDT, coal-tar creosote, pentachlorophenol, or orthodichlorobenzene. Their use must be in accordance with recommendations of service command headquarters.

(4) Fumigation and spraying are ineffective and not recommended for termite control.

Figure 53. Ventilation beneath the floor for prevention of termite damage and wood decay.

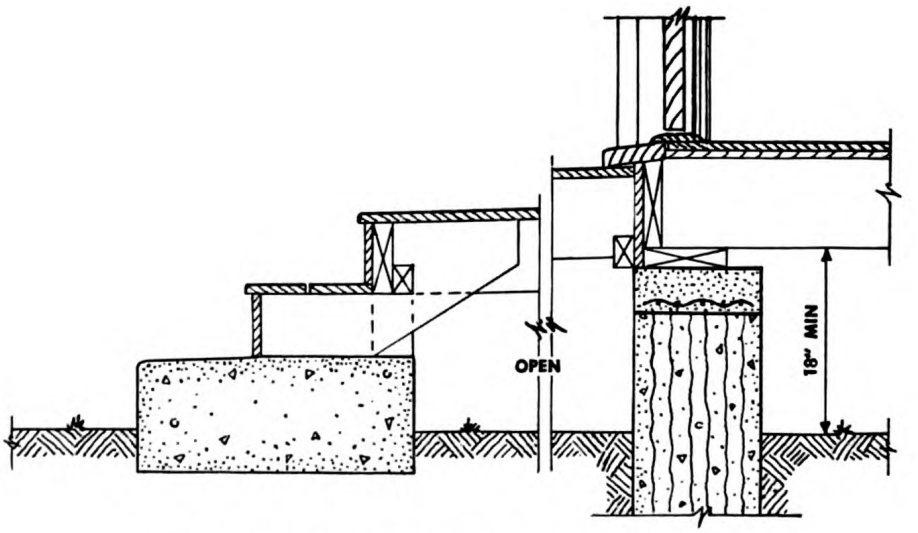
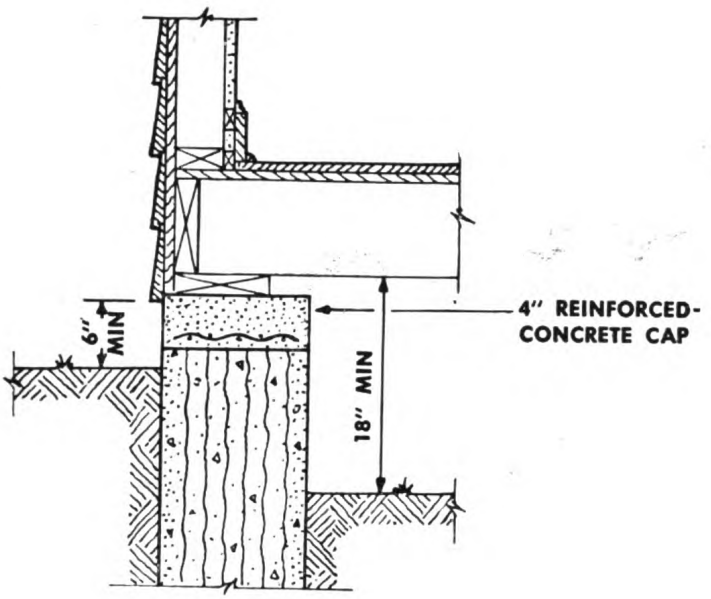
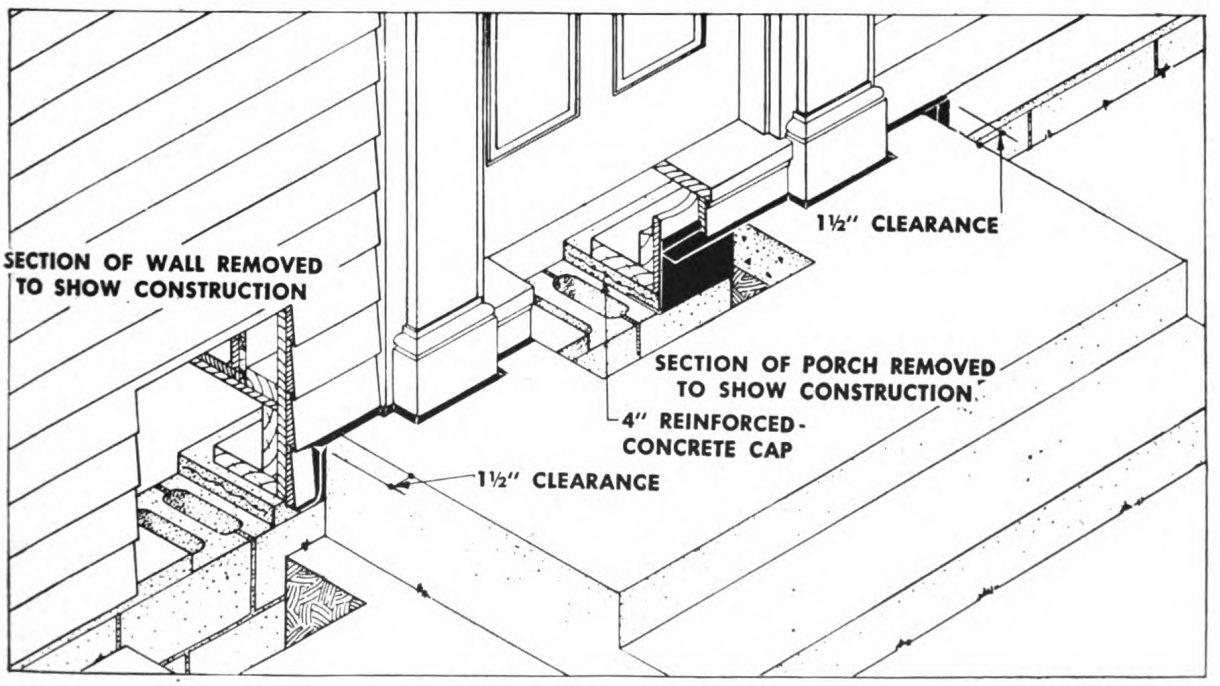


Figure 54. Wood steps resting on a concrete base.



①

① *Reinforced concrete cap, 4 inches thick.*



②

② *Metal protective apron at porches, steps, and terraces.*

Figure 55.

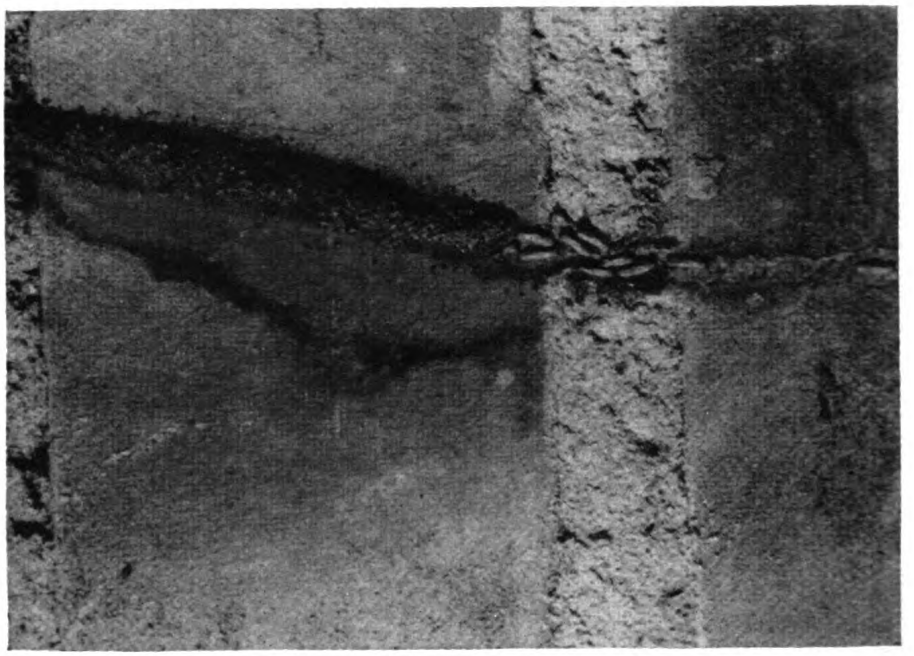


Figure 56. Section of shelter tube broken to expose termites.

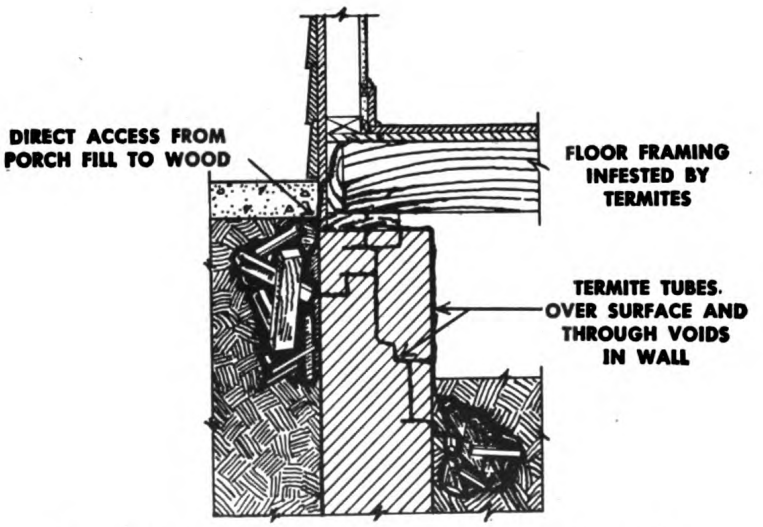


Figure 57. Wood buried in the soil about the foundation provides termite harborage.

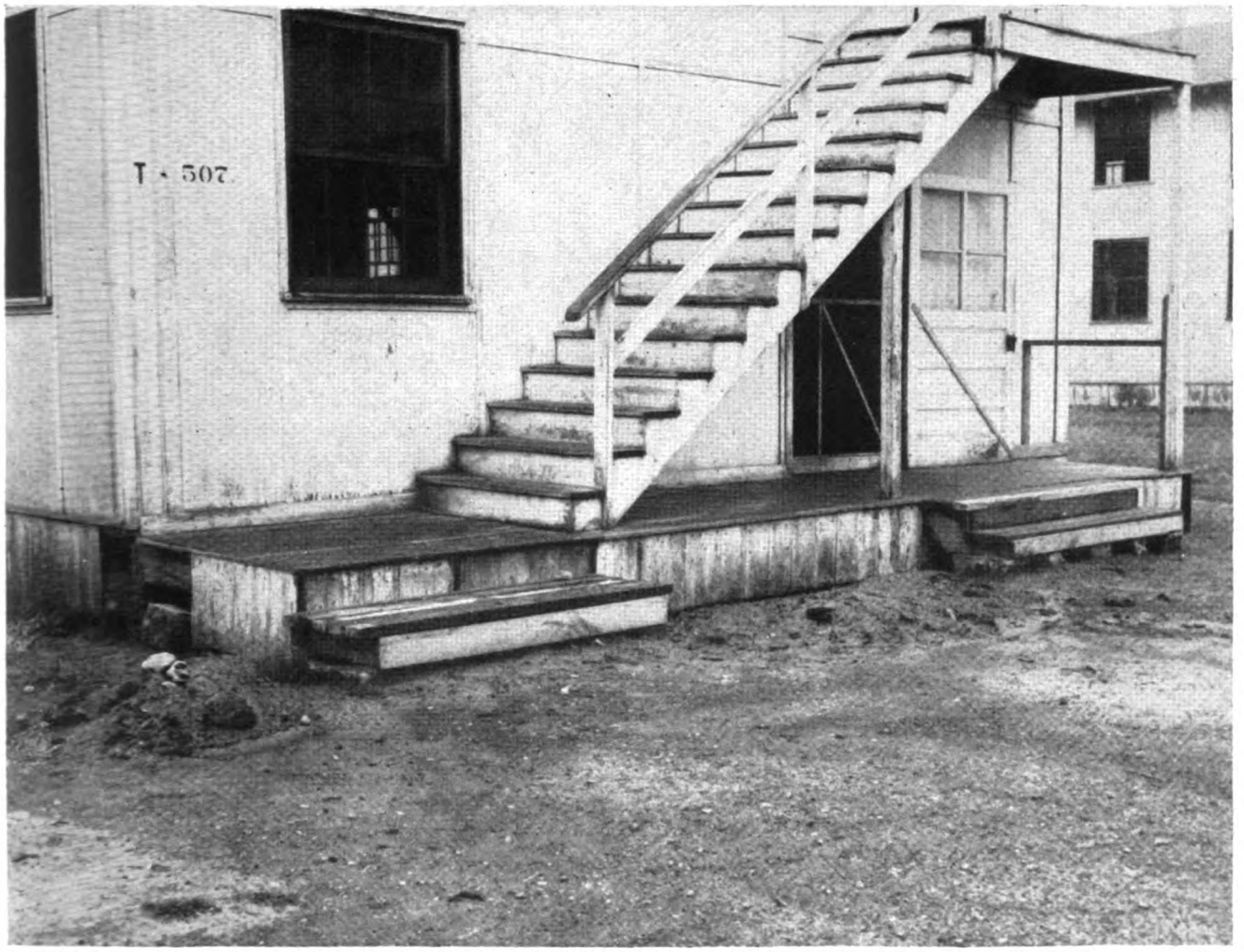


Figure 58. Wood skirting and steps in contact with ground affords termites access to building.

CHAPTER 11
RODENTS

49. General

Such rodents as rats, mice, and ground squirrels are reservoirs of infection for plague, endemic typhus, jaundice, and tularemia. They destroy large amounts of Army subsistence supplies, contaminate food stocks, damage buildings and equipment, and cause fire losses by gnawing the insulation of electrical connections. Rats commonly found on Army posts include Norway, black, and roof or Alexandrian rats. Identification of these species is made at the service command medical laboratory. Mice on Army posts that destroy stored foods, damage clothing, and injure shrubs are the house mouse, white-footed mouse, and meadow mouse. Other rodents that may require control measures are ground squirrels, prairie dogs, kangaroo rats, pocket gophers, and moles. In addition to rodents, the prairie wolf or coyote may require control on larger Army reservations of western States. Recommendations of the Medical Department regarding rodent control are contained in TB MED 144. The items for general supply and allowances of each for rodent control are contained in WD Circular 163, 1945.

50. Characteristics

a. Rats. Rats are largely nocturnal animals and feed chiefly at night. They are great travelers and may go several miles to forage for food; a large rat population may be present although only a few are seen. The brown or Norway rat is a burrowing animal and has great gnawing ability. It is found mainly in basements and on lower floors of buildings. Black and roof rats are good climbers and are often found in clumps of vines, trees, or lofts of buildings. All rats are omnivorous feeders, the brown rat preferring meats and fish while black and roof rats usually eat fruits and vegetables. Both kinds gnaw and destroy papers and cloth, being especially dangerous if they attack parachutes, etc. Locations affording shelter and food for rats at Army installations include piles of salvage lumber, areas under or near garbage racks, post exchanges, storerooms, warehouses, stables, and unoccupied buildings.

b. Mice. House mice often nest in stored mattresses, blankets, or other Army clothing. In preparing their nests, damage is done by gnawing the fabrics. The white-footed mouse and the meadow mouse are outdoor species. These small rodents may damage targets and supplies on rifle and pistol ranges. Also, the meadow mouse may girdle trees and shrubs and cause serious injury.

c. Ground Squirrels. Ground squirrels not only are a reservoir of infection for sylvatic plague in the western States, but also may damage the grounds at military reservations by raising mounds of earth around the burrows, destroying vegetation, and making rough surfaces. They burrow into ditch banks or other embankments to cause considerable damage.

d. Pocket gophers. Pocket gophers burrow underground most of the time and are seldom seen. These rodents are small and chunky, having fur-lined cheek pouches opening outside the mouth. Generally smaller than rats, they are found principally in the western States and also in Alabama, Georgia, and Florida. Although burrows constructed beneath vegetated areas are usually 4 to 8 inches deep, under special conditions burrows may be 6 feet deep. During the burrowing, gophers cut plant roots and cover grasses with mounds of earth. The ground surface may be seriously undermined by gophers; dams and embankments may be weakened.

e. Moles. Moles are insectivorous but occasionally cut bulbs and roots; their burrows are invaded by mice which eat bulbs and fleshy roots of all kinds. Mole burrows weaken the soil surface, causing unsightly and dangerous hummocks, and may destroy turf by aeration and drying of roots. This damage is of especial importance at airfields.

f. Coyotes. Coyotes, or prairie wolves, may find sanctuary on large Army reservations in the western States, traveling from this relatively safe

area to prey upon domestic animals and beneficial game species on nearby ranches or grazing areas. They are reservoirs of rabies. Under such conditions, control measures are recommended.

g. Foxes. Foxes also may use Army reservations for sanctuaries and may be of importance to Army personnel because they are frequently infected with rabies.

51. Control

An effective rodent control program requires a knowledge of the species involved and their habits. (See fig. 59.)

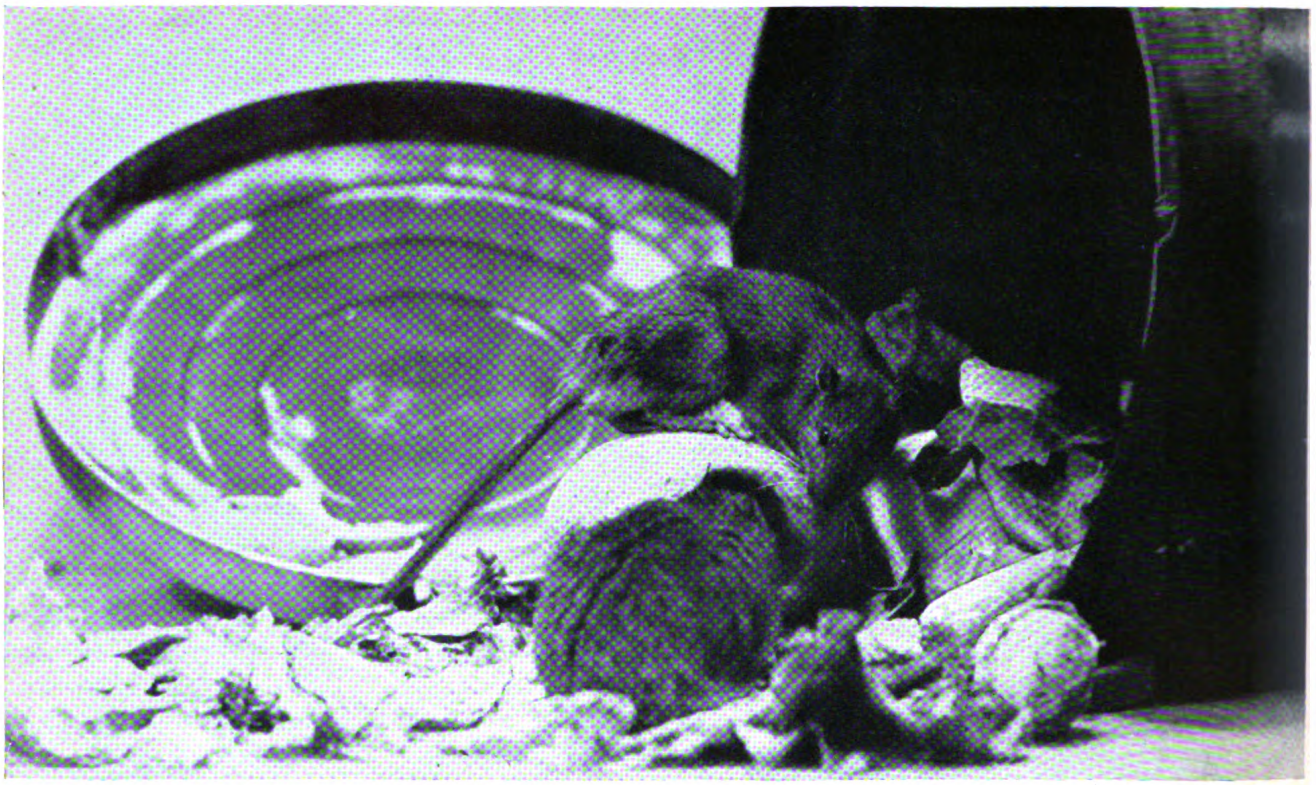
a. Rat control. Rat-control programs on Army posts should eliminate food and shelter, provide for ratproofing of buildings, poisoning, trapping, and fumigating.

(1) *Eliminating food and shelter.* Proper handling of food and prompt disposal of garbage to keep food from being available to rats is important in rat-control programs. Storage houses should be ratproofed or stored foods elevated on ratproof dunnage. Elevated platforms (pallet dunnage) with legs 14 inches high covered with sheet tin provide considerable protection. The stacked materials should be placed at least 2 feet from the wall. All disposable materials such as broken equipment, boxes, trash, garbage, and other items should be placed in the sanitary fill daily. (See fig. 60.) Directions for this method of waste disposal are found in TM 5–634 (when published). Open dumps may become infested without appearing so and should be eliminated.

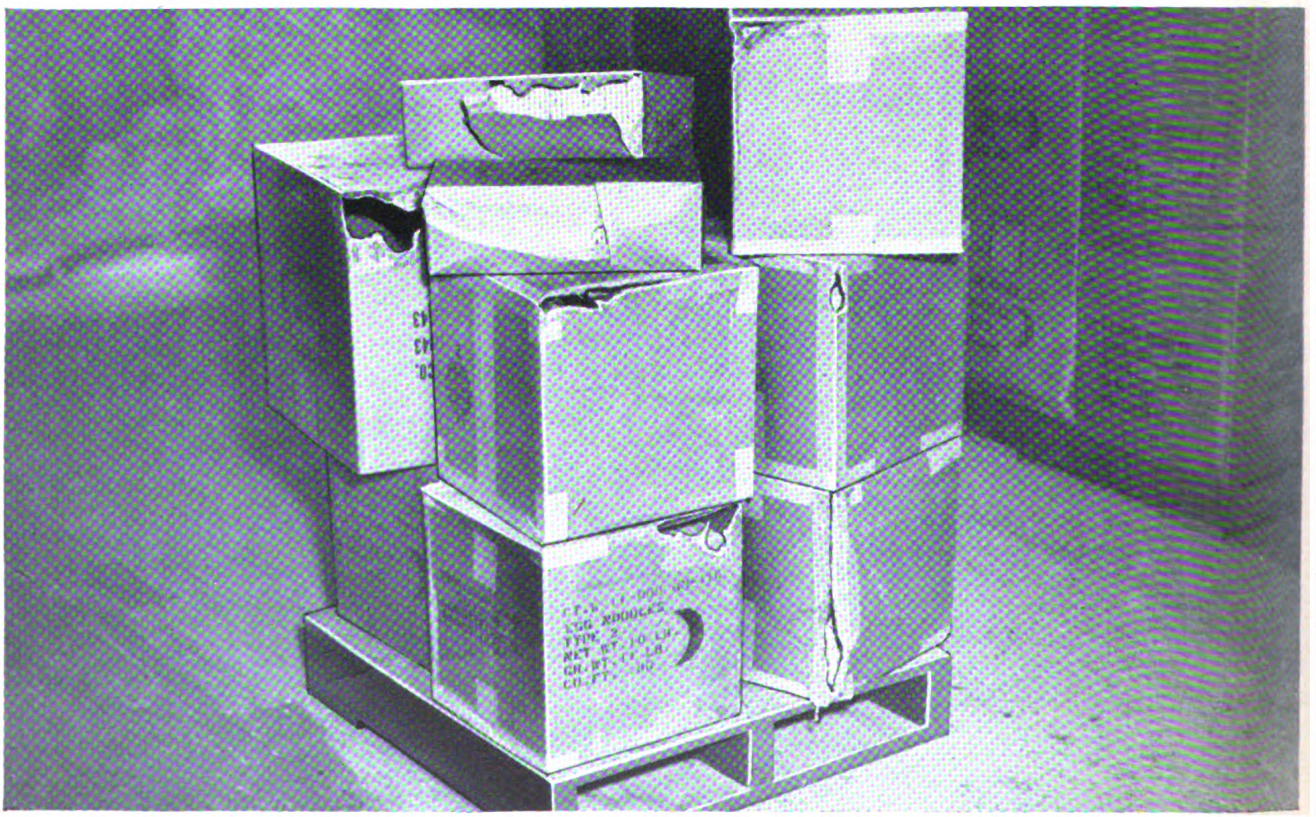
(2) *Ratproofing.* Ratproofing existing buildings and providing this protection for new construction is vital to rat control. (See fig. 61.) External construction of buildings accessible to rats should be of materials that resist their gnawing. Such openings as doors, gratings, or screens should be covered with screen of ½-inch hardware cloth. Openings around boxed-in piping should be closed with impervious materials. Fire stops in double walls and floors of wood construction should exclude rats. Doors should be self-closing and tight fitting. Programs for ratproofing build-

① *Adult brown or Norway rat.*

Figure 59.



② *Brown rats feeding on garbage.*



③ *Rat damage in subsistence supplies.*

Figure 59—Continued.

Figure 60. Sanitary fill method of waste disposal.

ings should be coordinated with the buildings and structures unit and receive adequate technical supervision.

(3) *Poison baits.* Poison baits are effective in rat control if properly planned and supervised. Since rat poisons are also poisonous to humans and domestic animals, they must be used with all recommended safeguards. The baiting process includes test baiting, prebaiting, and poisoning.

(*a*) *Test baiting.* Foods preferred by rats vary with the species and geographical area concerned. Before beginning a baiting program, all regular foodstuffs should be made inaccessible to rats and test samples of foods should be placed for one or two nights in locations frequented by the rats to determine which ones are most readily accepted. Test samples should be of three classes: cereals (bread, oatmeal, cornmeal, chicken mash, etc.), protein and fat (meat, fish, waste cooking grease, peanut butter), and fruits and vegetables (melons, sweet potatoes, bananas, and similar materials).

(*b*) *Prebaiting.* After determining the baits most likely to be taken, prebaits are prepared. They do not include the poison but are otherwise handled as poisoned baits. Many small baits are better than a few large ones, and the number should be adjusted so a few remain untaken to assure that every rat is supplied. About a spoonful of the bait material is wrapped in a piece of waxed or other strong paper to form a "torpedo." To protect baits from weather or insure inaccessibility to children and pets, feeding stations, small boxes 8 to 10 inches long and having a 4-inch interior diameter may be constructed. They are open at each end. Protecting stations or baits from contact with the hands is not necessary because rats are not repelled by human scent.

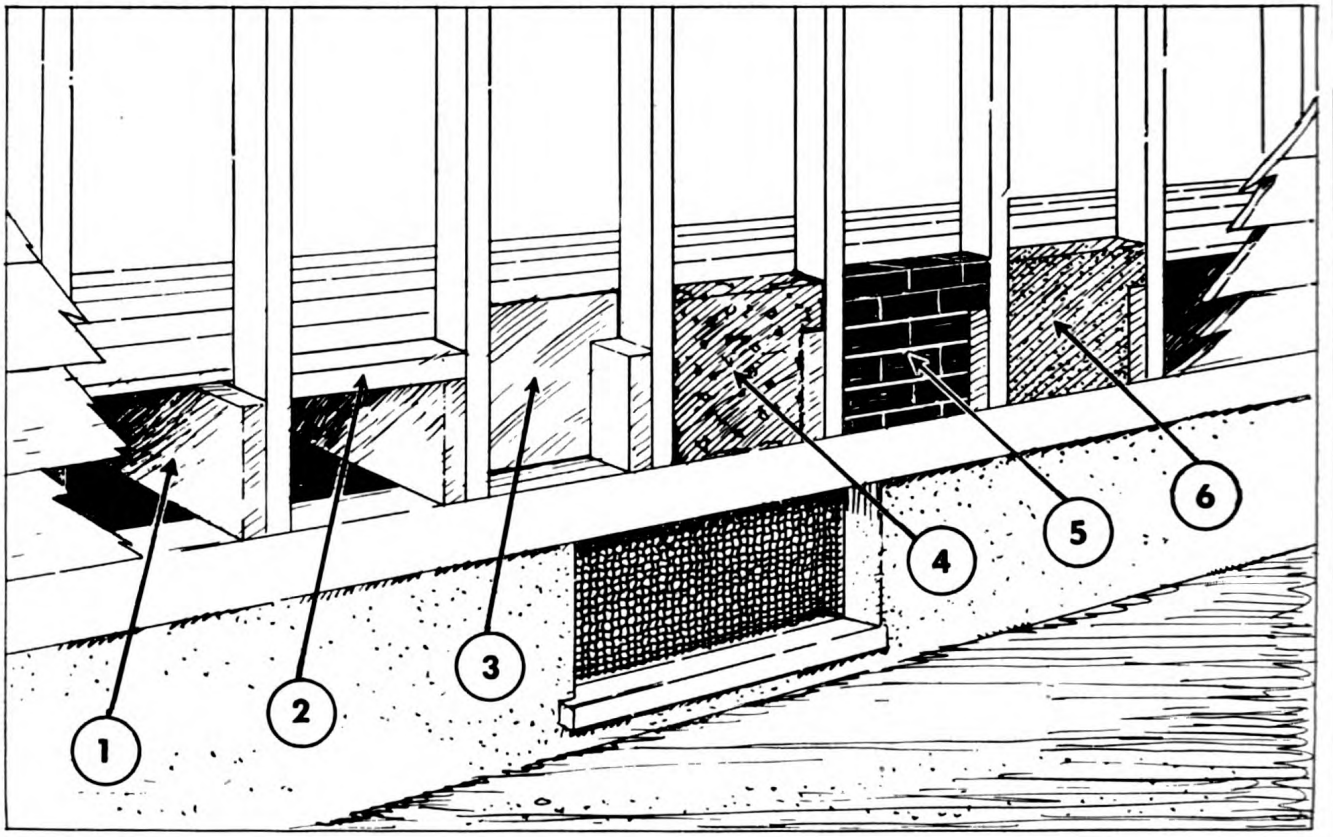
(*c*) *Poison baits.* When rats are feeding to the maximum extent on the materials, poisoned baits of the same kind are distributed. The poison is mixed with the oily constituents of the baits and then mixed thoroughly with the cereal and vegetable portions. Multiple type baits, containing more than one kind of food, are superior to single type baits. Changing the bait material increases its acceptance more than changing poisons, except that red squill is frequently refused if used repeatedly. The same bait material and poison should not be used twice within 2 months in follow-up treatments on the same area.

(*d*) *Bait formulas.* The following poison-bait formulas are recommended for rat control (fig. 62):

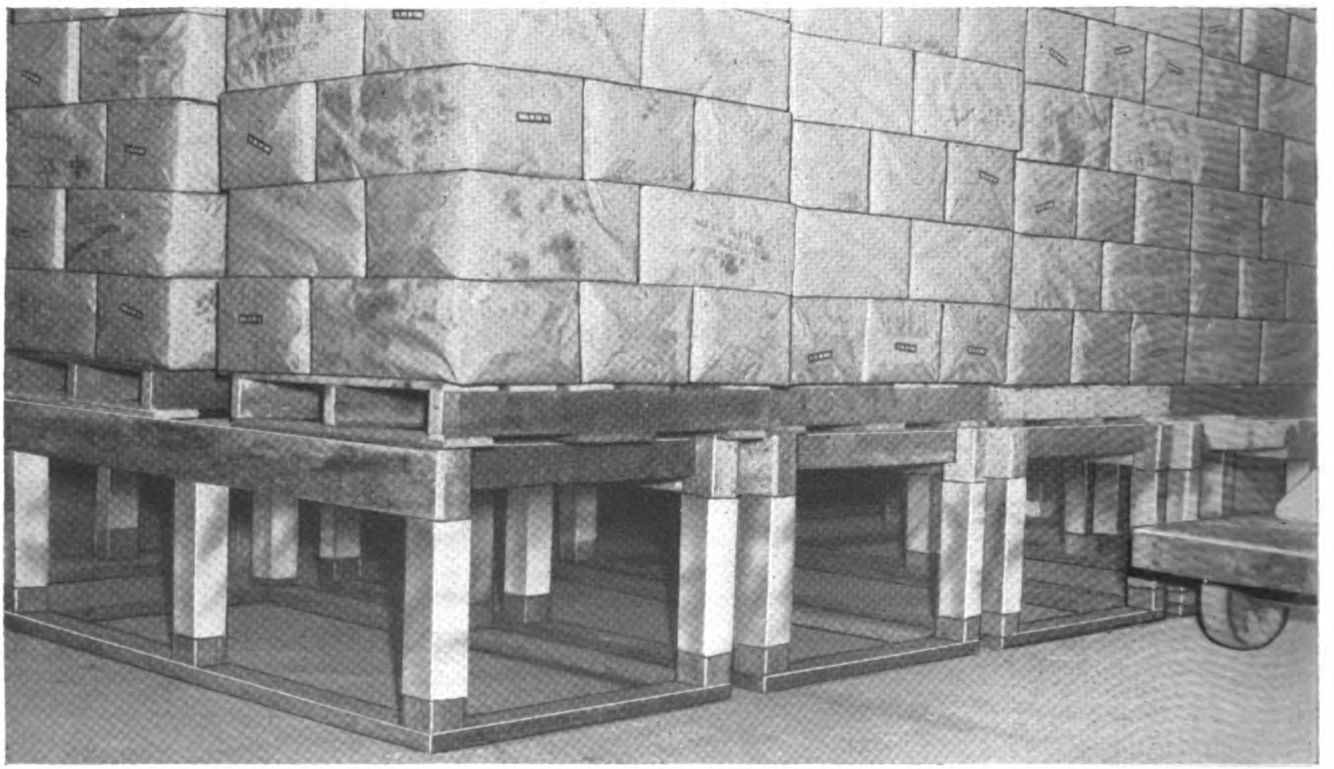
1. Brown or Norway rat.

Rolled oats or bread crumbs	3 pounds
Ground fish or meat	3 pounds
Corn oil	2½ ounces
Zinc phosphide	1 ounce

Note. Suspend poison in oil. Mix fish or meat with rolled oats. Add oil-poison mixture and mix thoroughly.



① *Ratproofing: (1) Open space giving rats free access. (2) Wood stops, 2 x 4. (3) Sheetmetal stops. (4) Cement and cinder stops. (5) Broken bricks. (6) Cement blocks.*

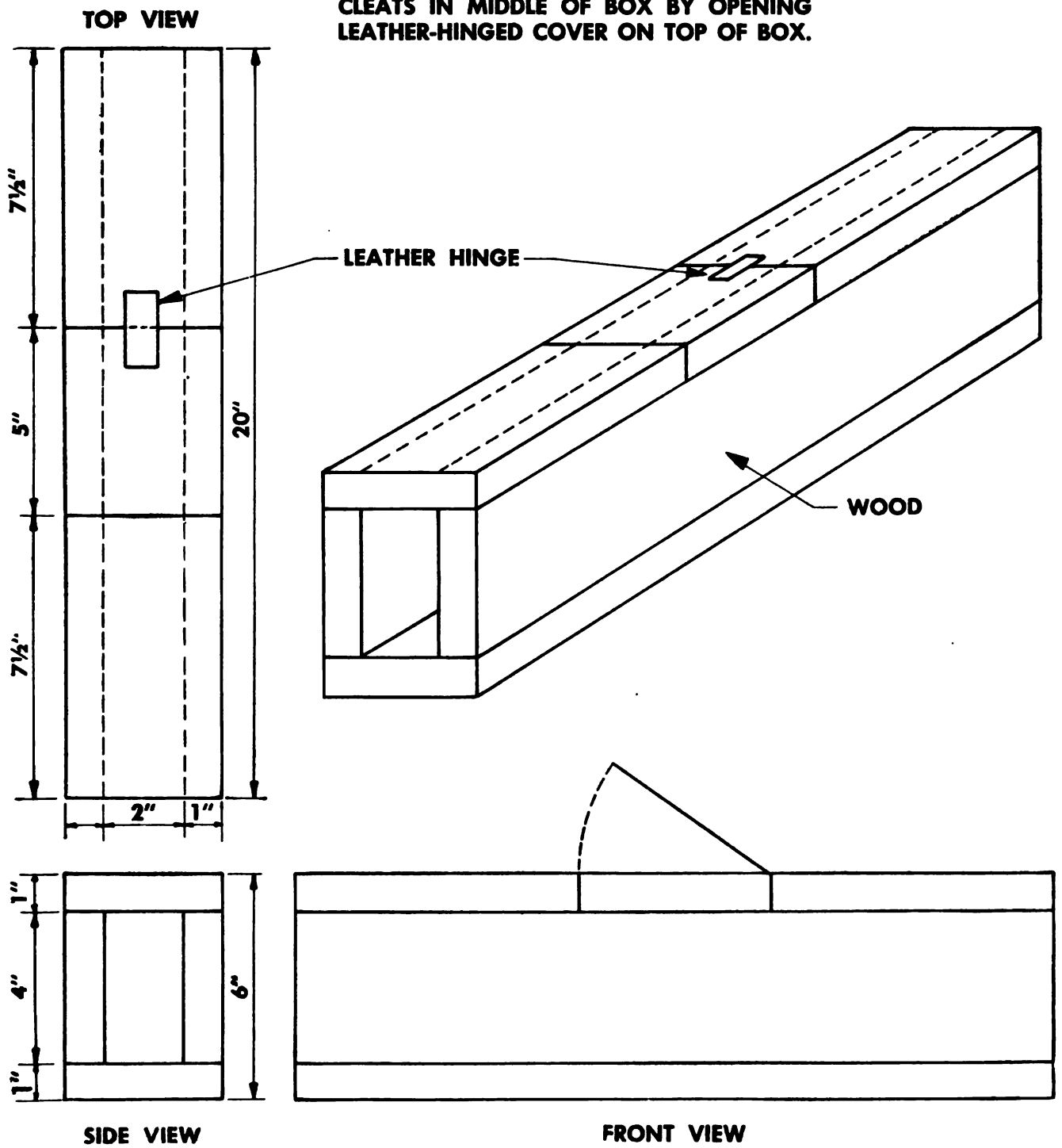


② *Dunnage for protection of supplies against rats.*

Figure 61.

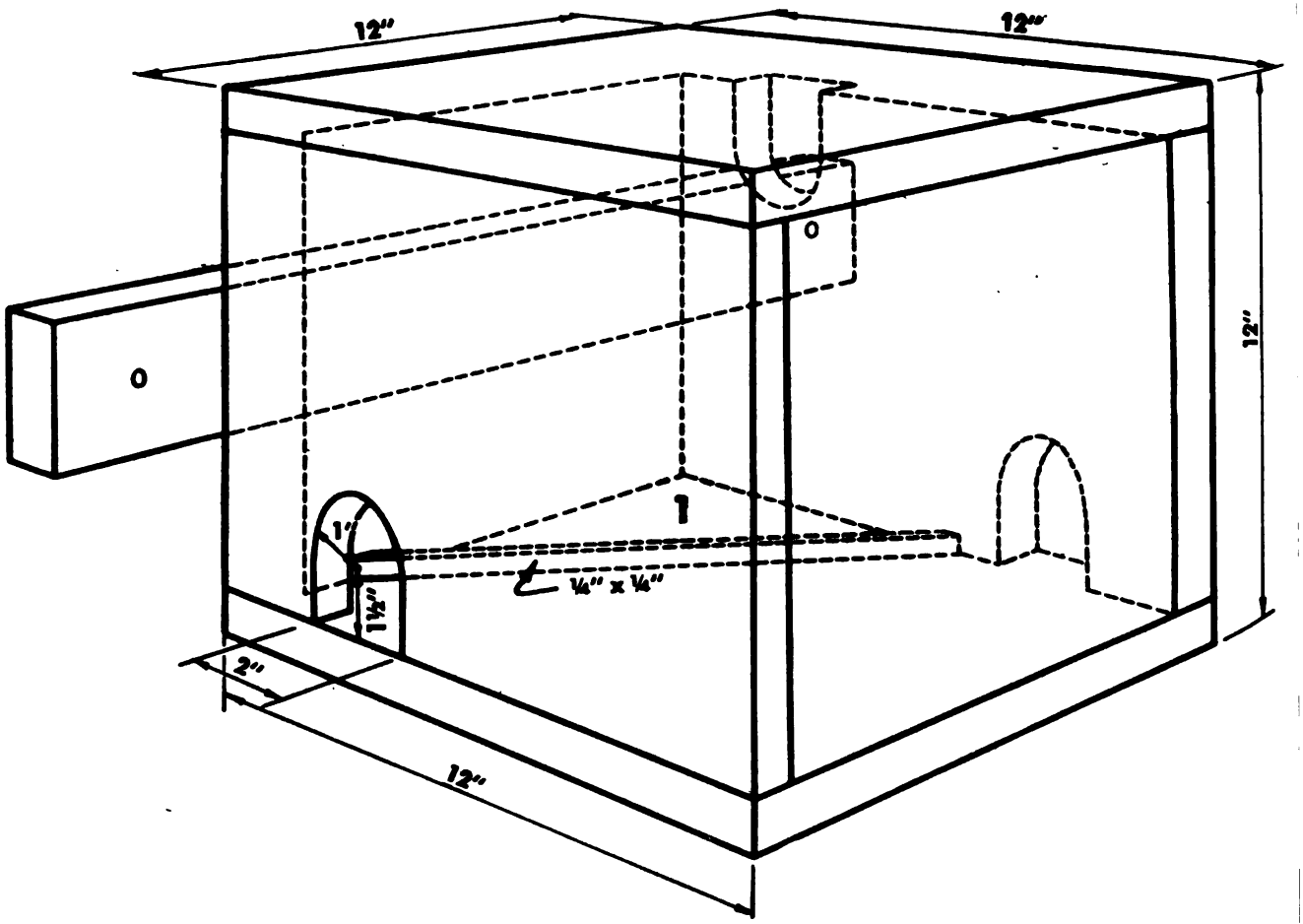
POISON BAIT BOX FOR RODENT CONTROL

NOTE: SMALL OPENINGS PERMIT A RAT TO ENTER EITHER END BUT ARE TOO SMALL FOR A CAT OR DOG TO REACH BAIT, WHICH IS PLACED BETWEEN TWO WOODEN CLEATS IN MIDDLE OF BOX BY OPENING LEATHER-HINGED COVER ON TOP OF BOX.



① *Poison-bait boxes used to protect baits from domestic animals.*

Figure 62.



② *Twelve-inch cubical box for safeguarding poison baits (baits placed in space 1).*

Figure 62—Continued.

2. Black and roof rats.

Raw sweet potatoes	6 pounds
or	
Raw cocoanut, ½-inch cubes	6 pounds
Zinc phosphide (QM stock No. 51–R–465 rodenticide general control	1 ounce

Note. Dust zinc phosphide lightly over cubes.

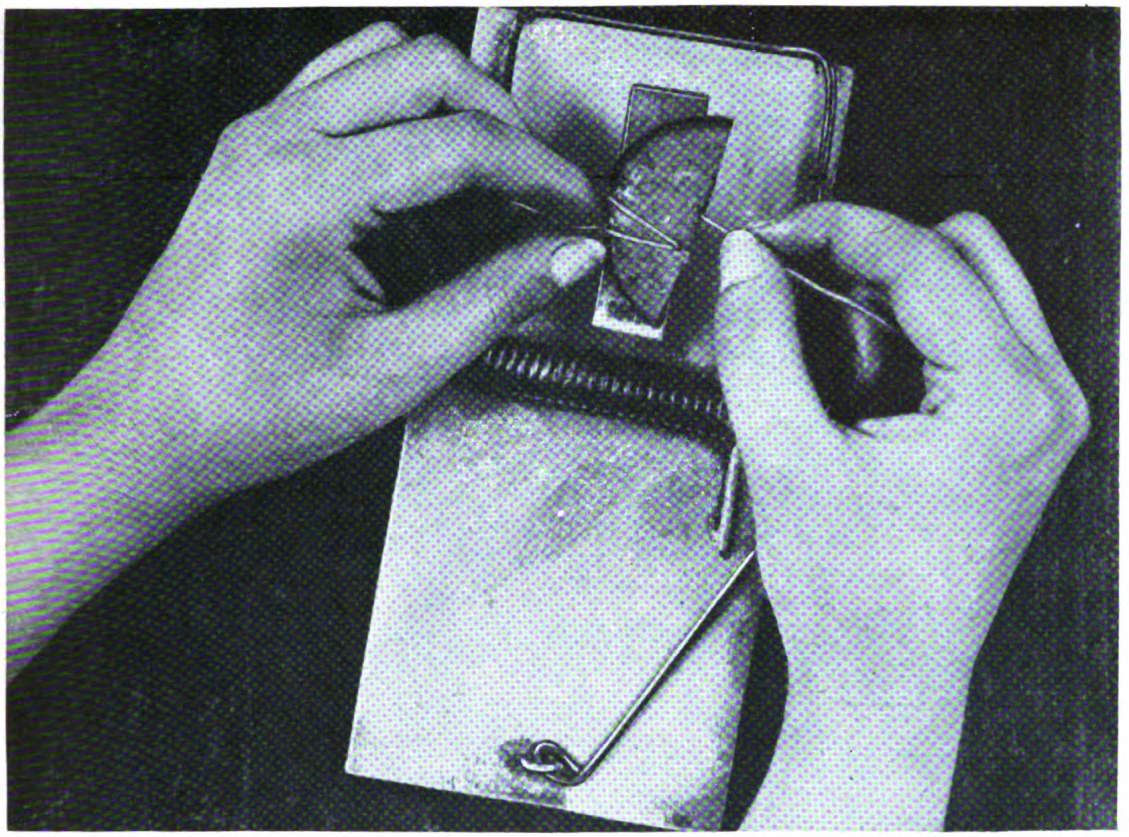
Rolled oats or bread crumbs	4½ pounds
Ground fish or meat	1½ pounds
Corn oil	5 ounces
Zinc phosphide	1 ounce

Note. Suspend poison in oil. Mix bait and oil-poison mixture and mix thoroughly.

(*e*) *Red squill.* Where quartermaster-issue materials are not available or poisonous materials cannot be used, red squill may be purchased by the post engineer. Red squill is an emetic that is relatively nontoxic except to rodents. It is now furnished in a fortified form having a standardized minimum lethal toxicity of 600 milligrams per kilogram of body weight for male rats. Rats made sick by red squill frequently refuse further baits containing this poison, making prebaiting particularly desirable. Red squill is mixed with bait material at the rate shown for the following formulas:

1.	Ground condemned meat	5 pounds
	Bread crumbs	4 pounds
	Red squill	1 pound
2.	Bread crumbs	8 pounds
	Waste cooking fat	1 pound
	Red squill	1 pound

(4) *Trapping.* Rat trapping is an effective indicator of rat population and is often recommended to supplement the baiting program. Locating traps along runways and in places frequented by rats requires skill; the odor of man, however, does not repel rats. The wood-base snap trap (fig. 63) is usually recommended (QM stock



① *Wood-base snap trap.*

② *Steel traps placed at entrance of rat harborage.*

Figure 63.

No. 42–T–12900). In humid climates, the wood base should be soaked in linseed oil to prevent warping. Other traps sometimes recommended are circular steel, box, and cage traps. Traps are used with or without baits, which may include bacon rind, walnuts, fresh coconut, and bread dipped in bacon grease. Traps should be set in rat trails or runways at right angles to the wall and should be placed so rats must pass over them in using runways. When traps are not baited, the trigger surface is enlarged with a piece of corrugated cardboard.

(5) *Fumigation* (fig. 64). Fumigation effectively destroys entire rat populations in treated spaces and also kills fleas that infest the rats in nests and burrows. In fumigating buildings and rat burrows, specially trained crews must do the work. Detailed instructions for the application of fumigants are contained in chapter 15. Hydrocyanic acid gas is an effective fumigant, dosages of 5 ounces for 1,000 cubic feet killing all rats and the fleas infesting them if exposure period is 4 to 6 hours. Only the rats are killed by doses of 2 ounces for 1,000 cubic feet with a 2-hour exposure. Calcium cyanide (QM stock No. 51–R–460: rodenticide, fumigant, dust) is recommended for rat burrows. It is applied with a foot-pump duster (QM stock No. 41–P–2975, pump, foot, rodenticide, fumigant). All burrows not used for injection of calcium cyanide should be tamped or otherwise sealed to make gassing more effective. This powder should not be used in buildings. For

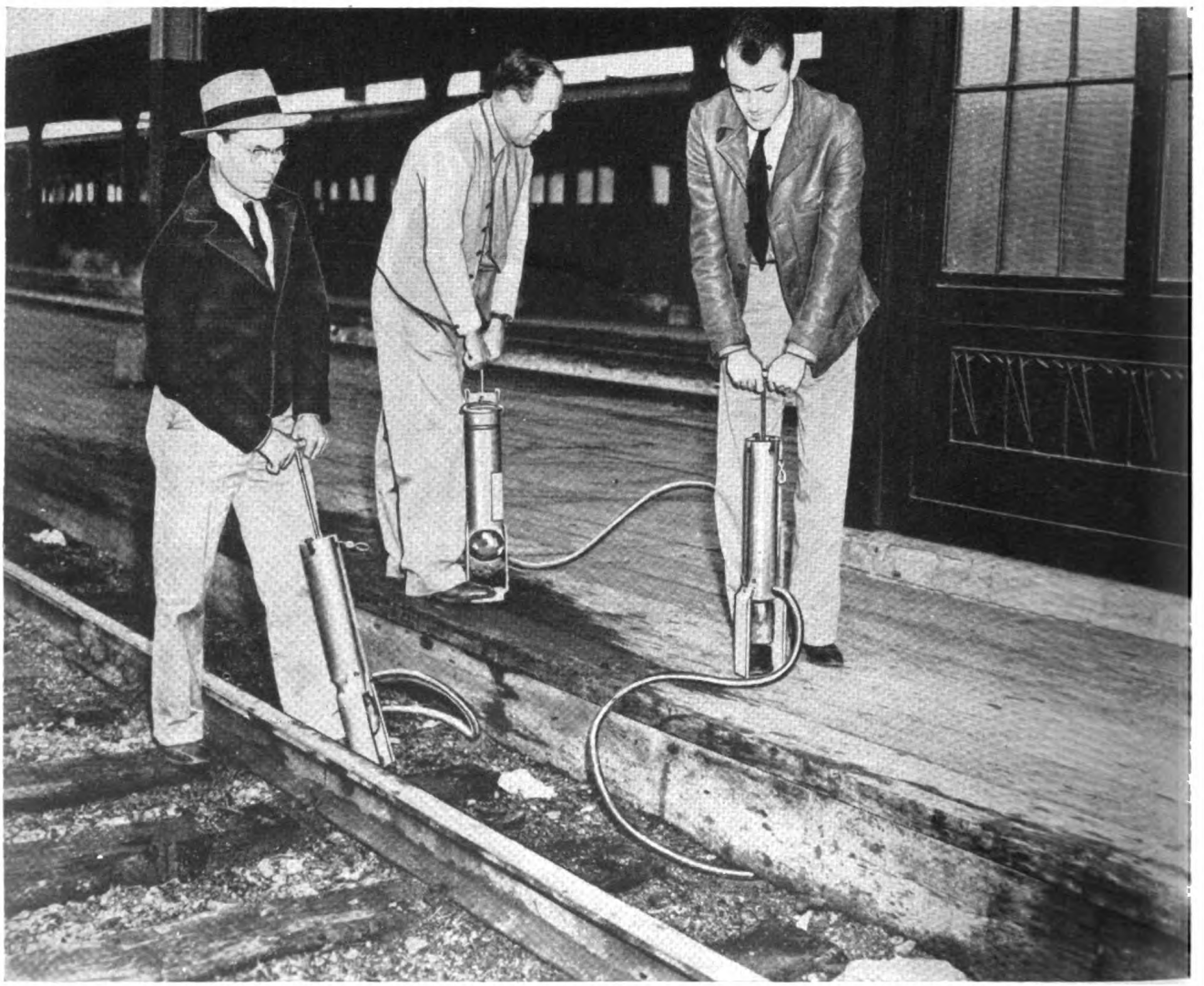


Figure 64. Application of calcium cyanide to rat burrows with foot pump duster: (QM stock No. 51–R–460, rodenticide, fumigant, dust and QM stock No. 41–P–2975, pump, foot, rodenticide, fumigant.)

building fumigation, HCN discoids are recommended if applied in accordance with procedures in chapter 15.

b. MOUSE CONTROL. In controlling mice, the species involved and their habits must be known. (See fig. 65.) House mice are found widely distributed in and around human habitations. Other species, such as the pine mouse and the meadow mouse, live in fields much like other field rodents.

(1) *Poison baits.* Poison baits may be used effectively, but must be safeguarded against misuse. The following formulas are recommended:

(*a*) *House mice.*

1. Bread crumbs	5¼ pounds
Powdered corn sugar	8 ounces
Corn oil	4 ounces
Zinc phosphide	1 ounce

Note. Blend poison and corn sugar. Add to bread crumbs and stir thoroughly. Stir in corn oil until mixture is moist.

2. Rolled oats or bread crumbs	5½ pounds
Ground fresh pork	8 ounces
Zinc phosphide	1 ounce

Note. Mix poison and oatmeal. Add ground pork and mix thoroughly.

3. Diced apples or sweet potatoes	3 pounds
Zinc phosphide	½ ounce

Note. Dust diced apples or potatoes with poison.

(*b*) *Meadow mice.*

Steamed roller oats	6 ounces
Petrolatum jelly	1 ounce
Mineral oil	1 ounce
Zinc phosphide	1 ounce

Note. Warm oil and petroleum until fluid but not hot. Add poison and stir until suspended. Pour over oats and mix thoroughly.

(2) *Mouseproofing.* Meadow mice may girdle trees and shrubs if vegetation or litter such as straw is allowed to accumulate around the base of the tree. (See fig. 66.) Vegetation within 1 to 2 feet should be cut and all debris that affords shelter removed. Where injury is likely, the trunk can be encircled by a guard of ¼-inch-mesh galvanized hardware cloth. The guard should extend about 4 inches below the ground surface and about 18 inches above.

(3) *Trapping.* The population of mice on Army posts is reduced by trapping and this control method is recommended. Small snap traps (QM stock No. 42–I–12500, (traps, mouse, spring type)) are effective. They may be set in runways without baiting or baited with poisons listed above. (See fig. 67.)

c. CONTROL OF GROUND SQUIRRELS. Control measures are sometimes necessary for ground squirrel infestations in the western States. Poison baits and fumigation are most generally recommended.

(1) *Poison baits.* Poison baits should be scattered during the dry season where the animals obtain their food. The following formulas containing zinc phosphide and strychnine are recommended:

(*a*) Whole grain barley or oats	14 pounds
Gloss starch	½ ounce
Bicarbonate of soda	1 ounce
Glycerin	¼ ounce
Heavy corn syrup	2 ounces
Strychnine, alkaloid	1 ounce
Water	14 ounces

Note. Mix starch with ¼ pint of cold water and stir remainder into boiling water. Mix strychnine with soda and add to starch paste. Add syrup and glycerin. Pour mixture over grain and turn until all kernels are uniformly coated.

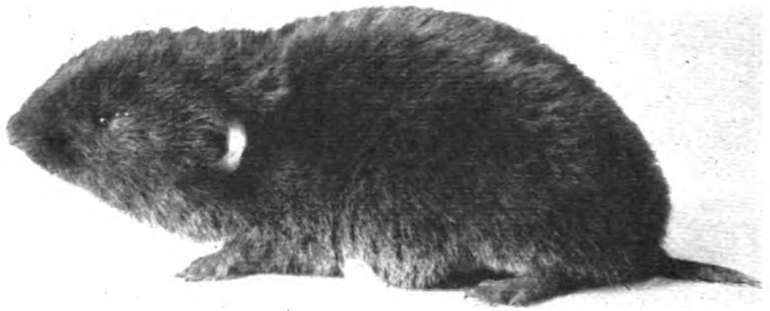
(*b*) Rolled oats	10 pounds
Petrolatum jelly	1 ounce
Mineral oil	½ ounce
Zinc phosphide	1 ounce

Note. Blend jelly and oil by heating. Add poison and pour over the grain. Turn until grain is thoroughly coated.

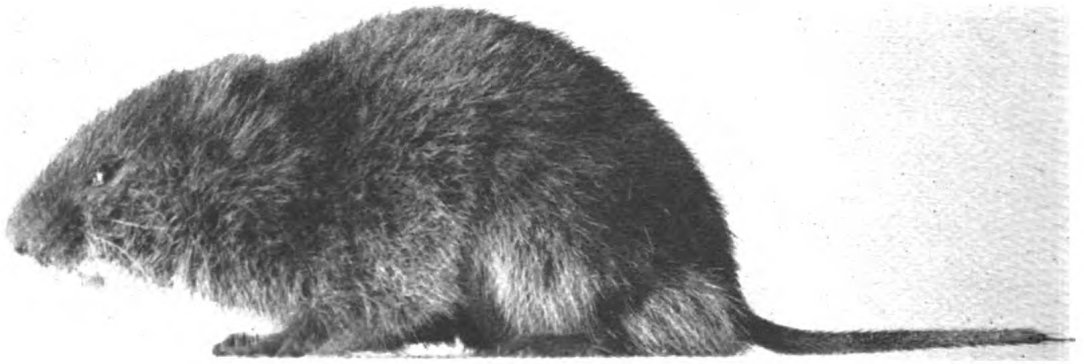
(2) *Fumigation.* Fumigation of squirrel burrows with calcium cyanide (QM stock No. 51–R–460) is effective. The powder is applied to burrows with the foot-pump duster. Methyl bromide applied at the rate of about 10 cubic centimeters for each burrow and carbon disulphide at the rate of 1 ounce for each burrow are other fumigants sometimes recommended. The fumigation work should be done only by trained personnel who observe all precautions. Masks need not be worn outdoors, but care must be taken to avoid breathing fumes from the dust. (See ch. 15.)

d. CONTROL OF POCKET GOPHERS. Pocket gophers live underground where grain and other foods are stored in the burrows. (See fig. 68.) Trapping and poisoning are the control measures usually recommended.

① *House mouse, adult.*



② *Pine mouse, adult.*



③ *Meadow mouse, adult.*

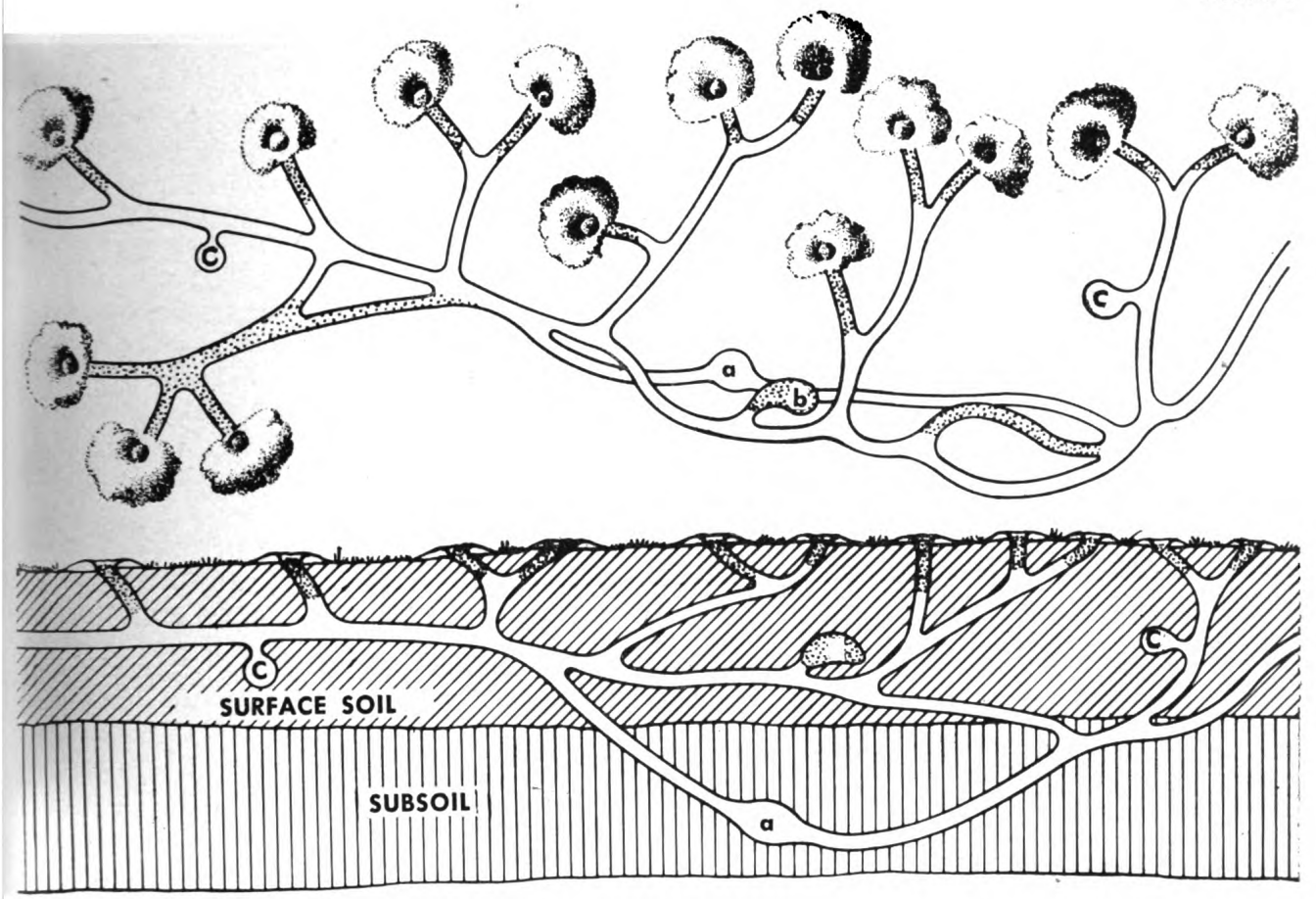
Figure 65.

Figure 66. Environment favoring damage to trees and shrubs by meadow mice.

① *Baiting station for field mice.*

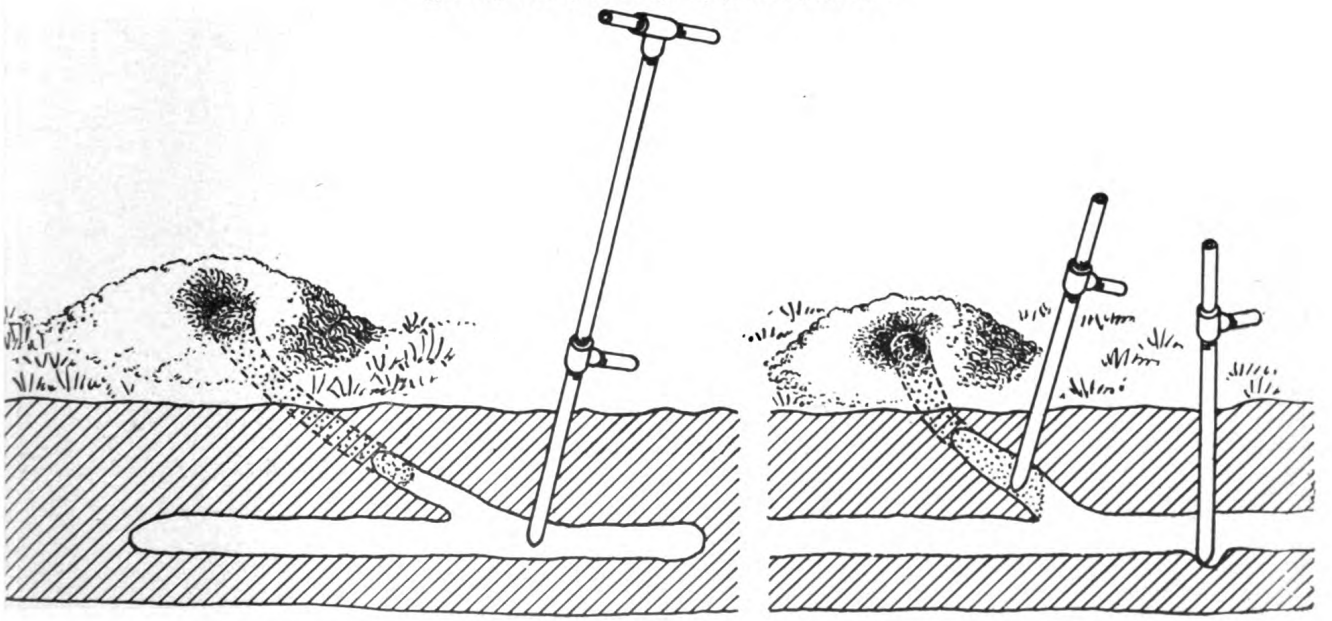
② *Snap trap for mice.*

Figure 67.



1

① *Diagram of runways of pocket gophers.*



2

② *Probe for runways of gophers.*

Figure 68.

(1) *Trapping.* Trapping is the most satisfactory method of controlling pocket gophers on small areas or where only a small number are present. Macabee type traps, designed especially for catching pocket gophers, may be ordered direct from the Macabee Gopher Trap Company, Los Gatos, California. (See fig. 69.) The following directions for trapping pocket gophers are given by the U. S. Fish and Wildlife Service:

(*a*) In placing traps, a freshly constructed mound should be selected and the burrow located. The mounds are more or less fan-shaped, with the plugs of the laterals or side runways at the base. The lightly plugged opening of the lateral is cleaned out with a long-handled iron spoon or a strong garden trowel and enlarged sufficiently to admit the trap. Trap setting is done in the lateral if it is long enough so the trap does not extend into the main runway. Setting the traps in the main runways rather than in the laterals is often advisable.

(*b*) The main runway may be located with a probe or found by digging out the lateral to its junction with the main runway. In the main runway, two traps should be used, one facing each way because pocket-gopher traps can be entered from only one direction.

(*c*) Traps in either a lateral or a main runway should be placed 12 to 18 inches back, and the burrow should be left open or only partly closed because air and light bring the gopher to repair the break. Baiting is neither necessary nor advisable.

(*d*) Fastening the lighter traps to stakes with a light wire or cord is advisable. A single strand of galvanized clothesline wire is satisfactory because it does not rust and is pliable enough to keep the trap from being tilted in setting. If the trap is not fastened, the captured gopher may escape with the trap or some animal may carry away both rodent and trap.

(2) *Poison bait.* For gopher infestations in large areas, poisoning is the most effective control measure. Preparation and distribution of bait must have proper technical supervision. Food of these animals under natural conditions consists chiefly of the roots, tubes, and bulbs of plants. Baits are prepared from cut sections of sweet potatoes and carrots or from such grains as oats or wheat. Fresh clover and alfalfa leaves also have been used successfully. Baits should be placed

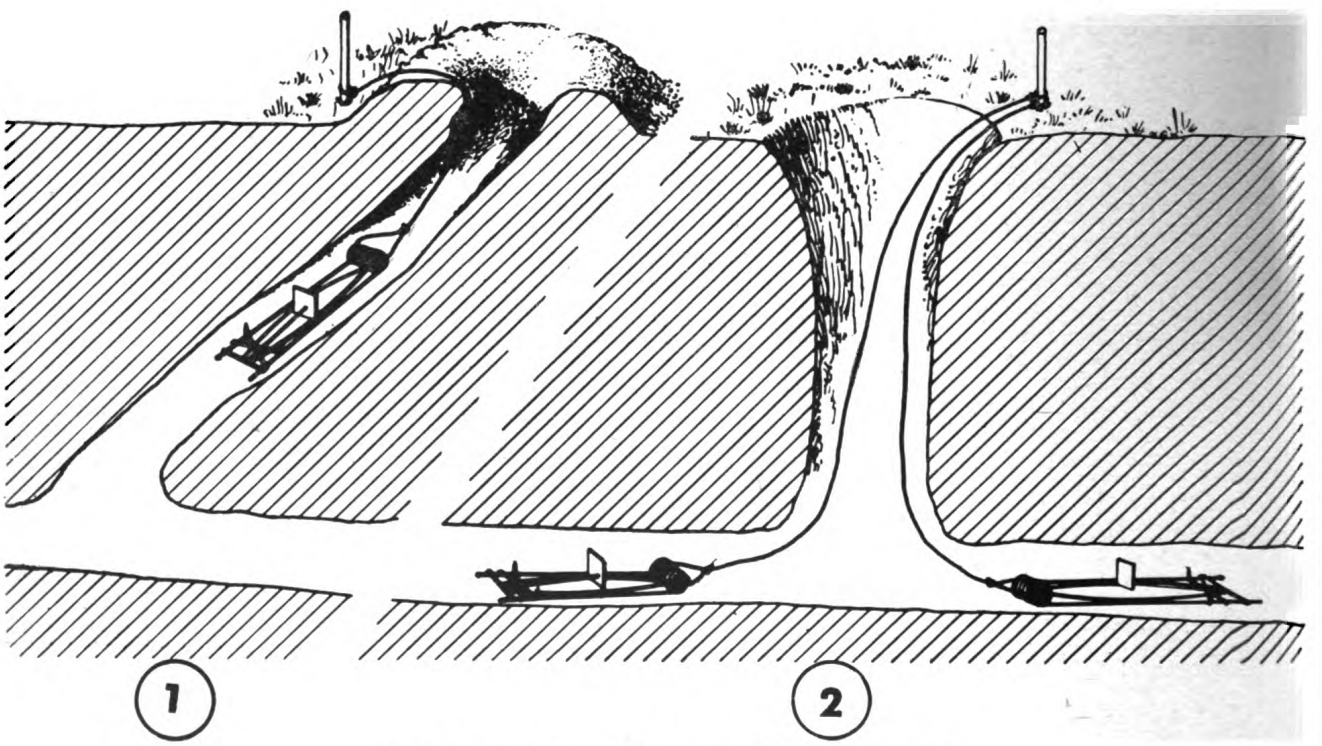


Figure 69. Trapping gophers with the Macabee trap.

in the main runways. In addition to the first formula given in (*a*) above for ground squirrels, the following is recommended:

Sweet potatoes or carrots_____ 2 quarts
or fresh clover or alfalfa_____ 1½ pounds
Strychnine alkaloid_____ ⅛ ounce

Note. Cut baits about 1½ inches long and potatoes and carrots about ¼ inch thick. Dust strychnine alkaloid on the baits and mix thoroughly.

e. Control of Coyotes (fig. 70). On some large Army reservations in the West, coyotes or prairie wolves may find sanctuaries from which they forage to destroy game and domestic animals on neighboring ranches and grazing areas. Under these conditions, post engineers may be called upon to apply control measures. The services of specialists of the Fish and Wildlife Service, Department of the Interior, should be obtained for technical assistance. Trapping is usually recommended.

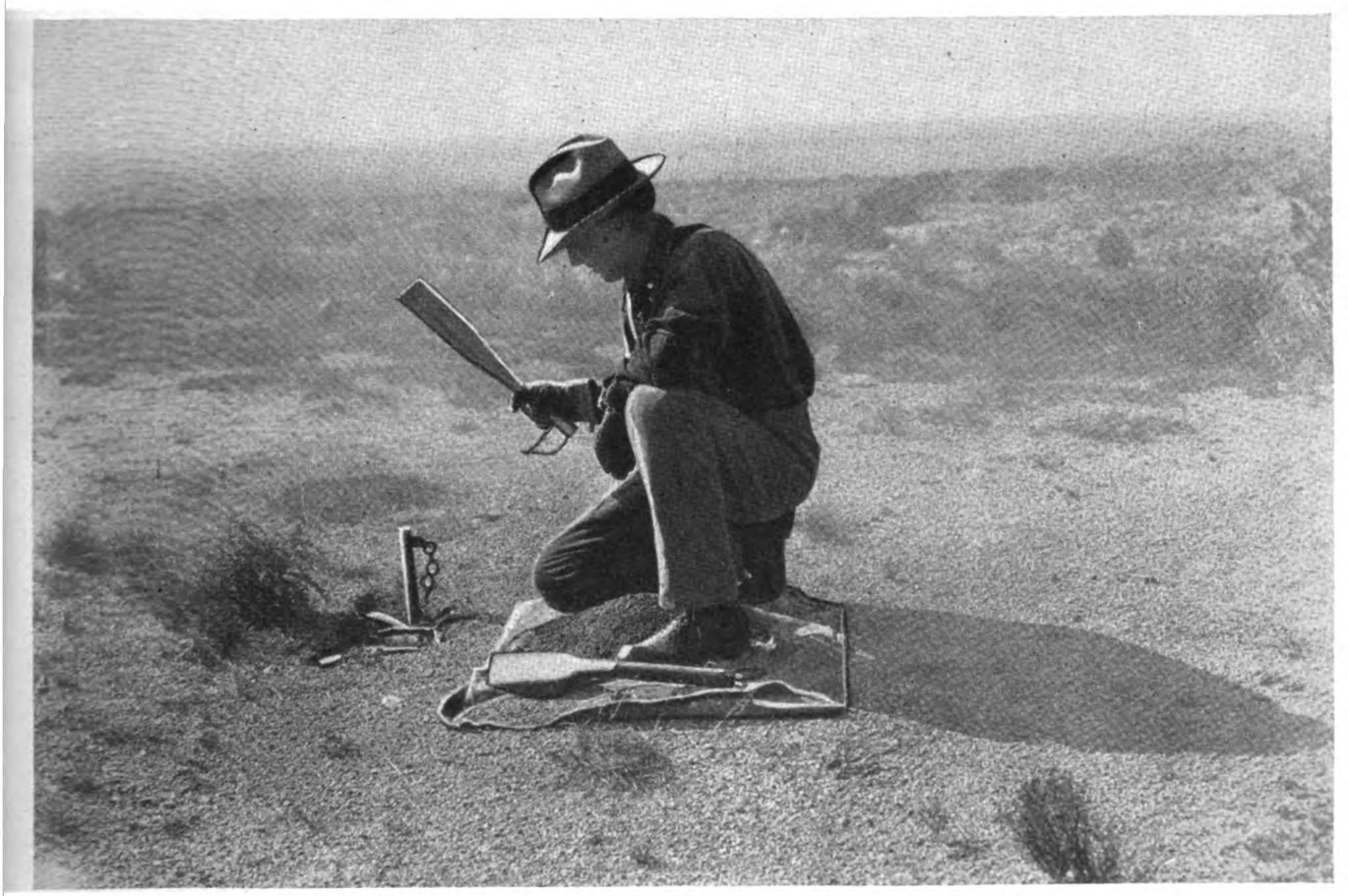


Figure 70. Setting coyote trap: trap, gloves, mat, shovel, mallet, scent bottle.

CHAPTER 12
COCKROACHES

52. General

Cockroaches are widely distributed in the United States and may infest mess halls, post exchanges, hospitals, kitchens, barracks, and other buildings on the post. (See figs. 71, 72, and 73.) These active, long-legged, flat-backed insects occur in several species, including German (croton bug or water bug), the oriental, American (largest of the common species), Australian, and brown-banded roaches. Species may be identified by sending specimens to the service command medical laboratory.

53. Characteristics

Cockroaches thrive in the presence of food, warmth, and sheltered locations. Most of their activity is at night, roaches remaining concealed in cracks or hiding places during the day. They are often found at steam tables, sinks, drains, shelving, and double walls in mess halls, latrines, and food-storage places. Foraging in kitchens and mess halls, they contaminate foods, tables, food carts in hospitals, shelves, and similar places. Scent glands possessed by the insects exude a disagreeable roach odor.

54. Control*

Roach control includes good housekeeping by troop units, knowledge of the habits and hiding places of the insects, use of effective insecticides, and a continuing control program.

a. Sodium Fluoride. Roaches can be controlled by weekly or monthly applications of sodium fluoride roach powder (QM stock No. 51–I–210: insecticide, powder, roach). This dust may be applied by troop units as a housekeeping function or by the post engineer to buildings certified by the post surgeon. The powder should be applied under proper supervision with

*Control measures given for roaches have also been effective against house crickets.

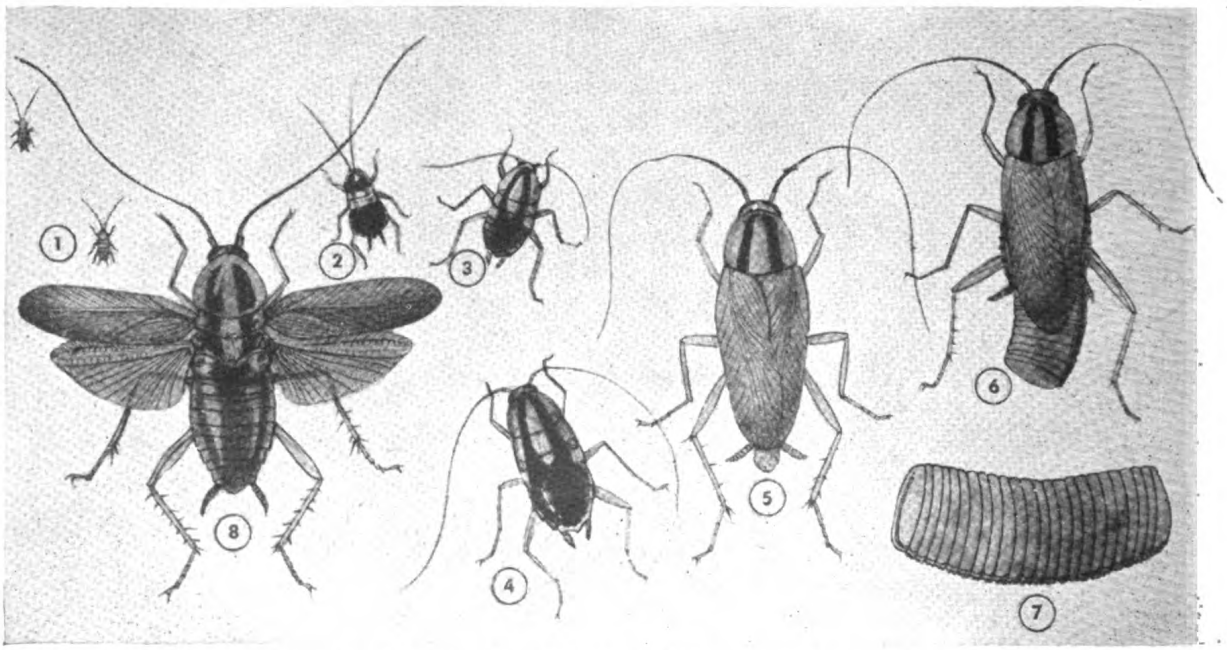


Figure 71. German cockroach: 1–4, nymphs; 5 and 8, adults; 6, adult female with egg case; 7, egg capsule.

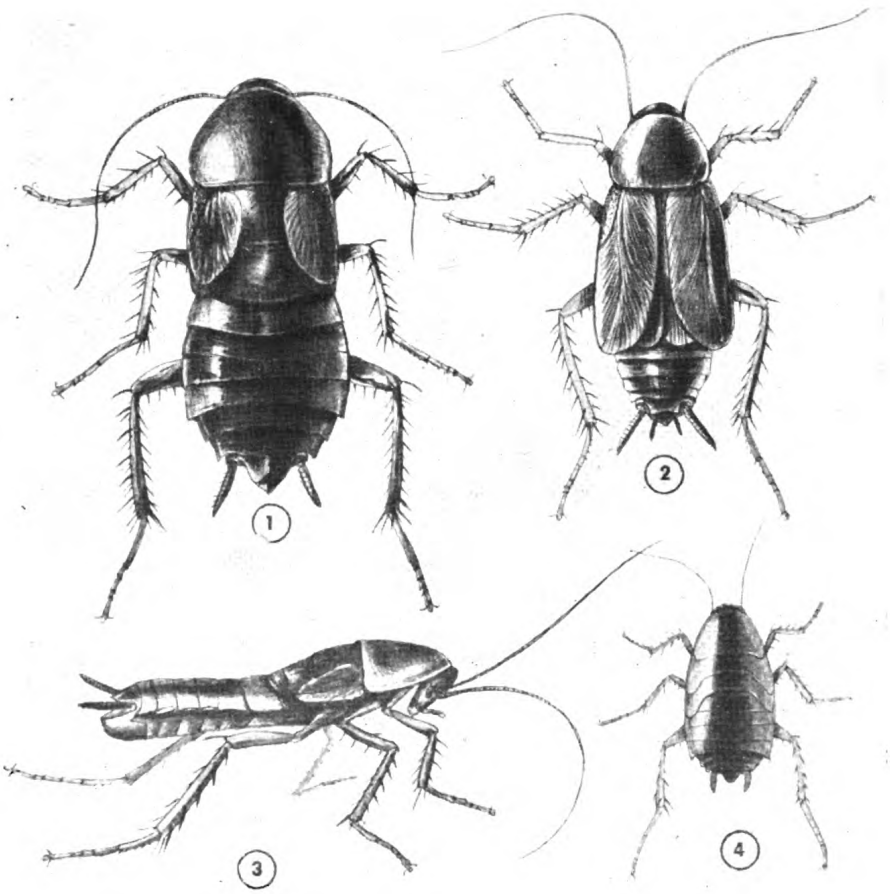


Figure 72. Oriental cockroach: 1 and 3, adult females; 2, male; 4, half-grown nymph.

a plunger duster (QM stock No. 41–D–3750). When present supplies are exhausted this material will not be a standard item of issue. It is expected that DDT dusts and sprays will replace it.

b. DDT Dust. DDT dust is now available for use against cockroaches (QM stock No. 51–L–122: Larvicide, DDT, powder dusting). Applied with a plunger type duster, it should be blown into all crevices in walls, pantries, behind sinks, underneath mess tables, refrigerators, serving tables, door facings, mirrors in latrines, and similar locations. The dust should remain dry to be most effective and should not be removed or wetted when deposited in double walls, or behind baseboards, or other locations safe from food contamination. DDT dust should not be stored with food. The containers used for storage should be plainly marked to indicate poisonous material. Directions for use are contained on packages of DDT dust issued by the post supply officer and should be followed without deviation.

c. DDT Sprays. A 5 percent DDT spray in kerosene (QM stock No. 51–I–305: Insecticide, spray, DDT, residual effect) is an effective roach control. The spray should be applied without fogging to all surfaces, especially cracks and crevices where roaches travel or hide. The sprayed surfaces should be wet to the point of run-off. A coarse wet spray is obtained by using a disk nozzle with a $\frac{3}{64}$-inch opening and holding nozzle 4 to 6 inches from surface being sprayed. A dosage of about 1 quart of spray should be applied for each 250 square feet of space.

d. Fumigations. Under extreme conditions of infestation or because of a shortage of DDT insecticides, fumigation may be recommended by the post surgeon. Although this method insures

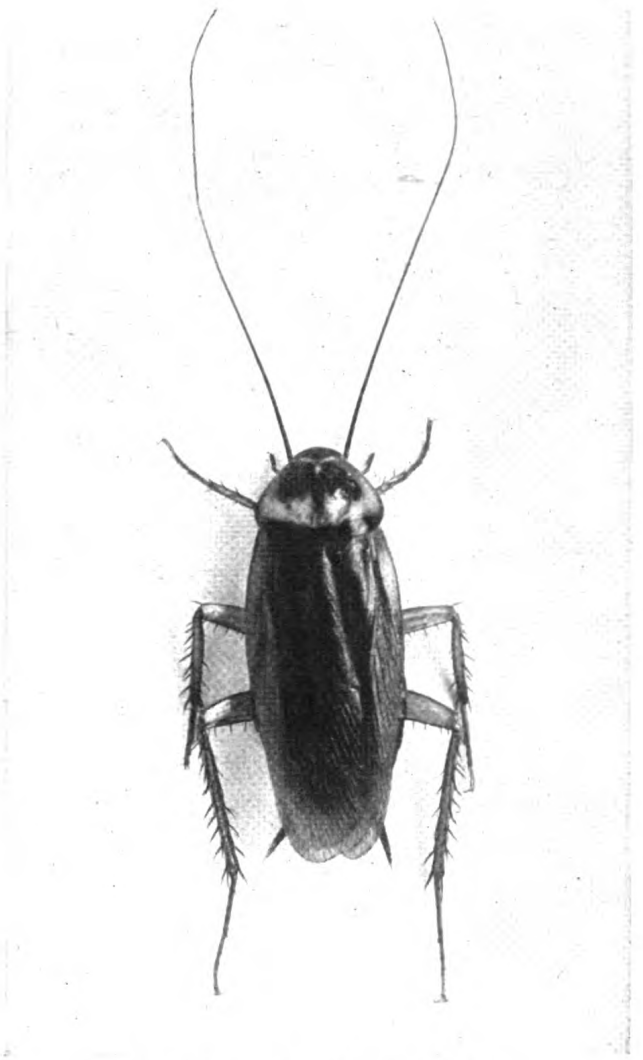


Figure 73. American cockroach.

a large kill of insects, it does not prevent immediate reinfestation because roaches hiding beneath and around the exteriors of buildings reenter at once. For satisfactory results, fumigation must be followed by a thorough application of DDT dust or spray. If buildings are certified to the post engineer for roach-control fumigation, directions and precautions given in chapter 15 should be followed. The work must be done by a trained, properly certified fumigation team.

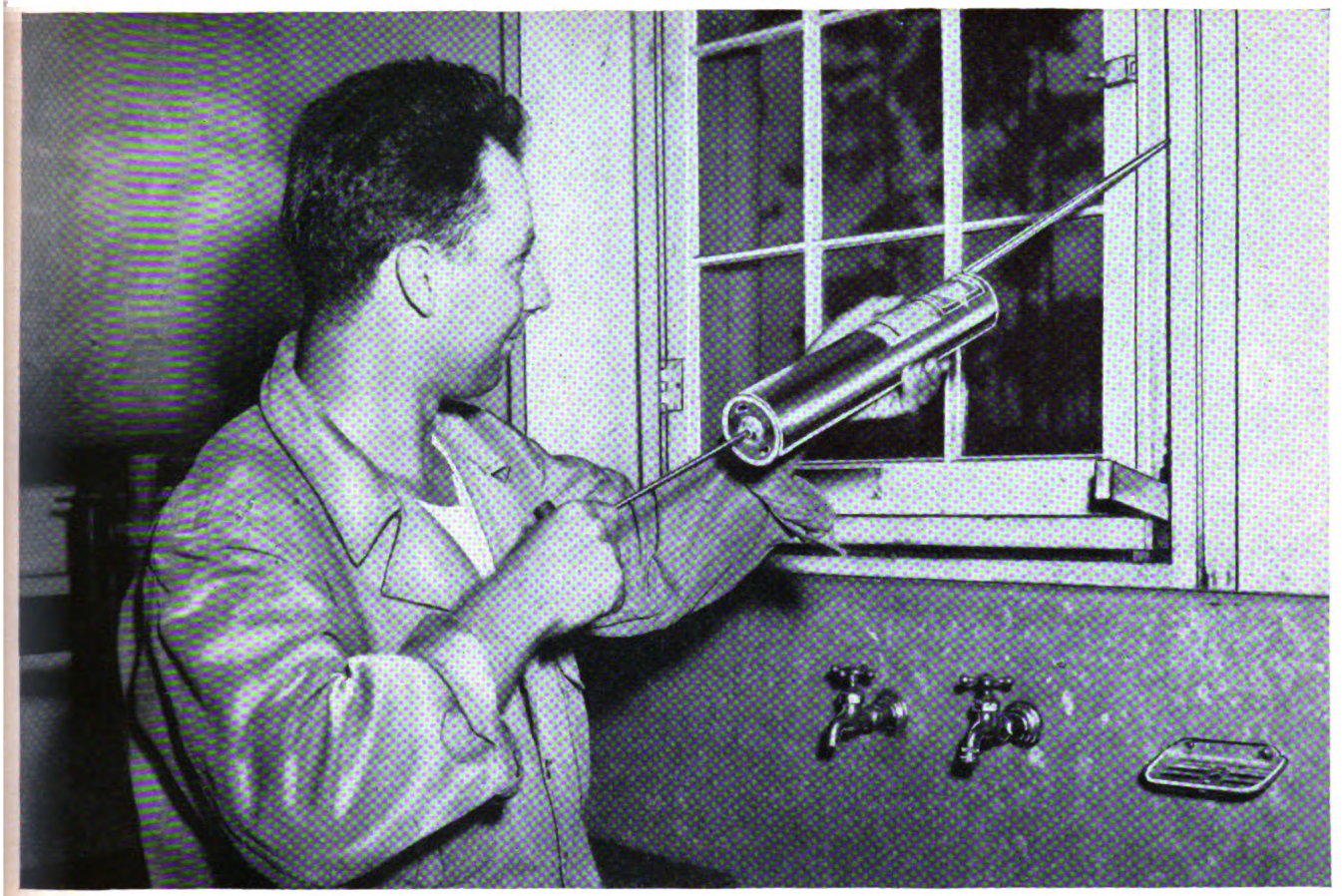


Figure 74. Application of DDT dusts with plunger duster for cookroach control.

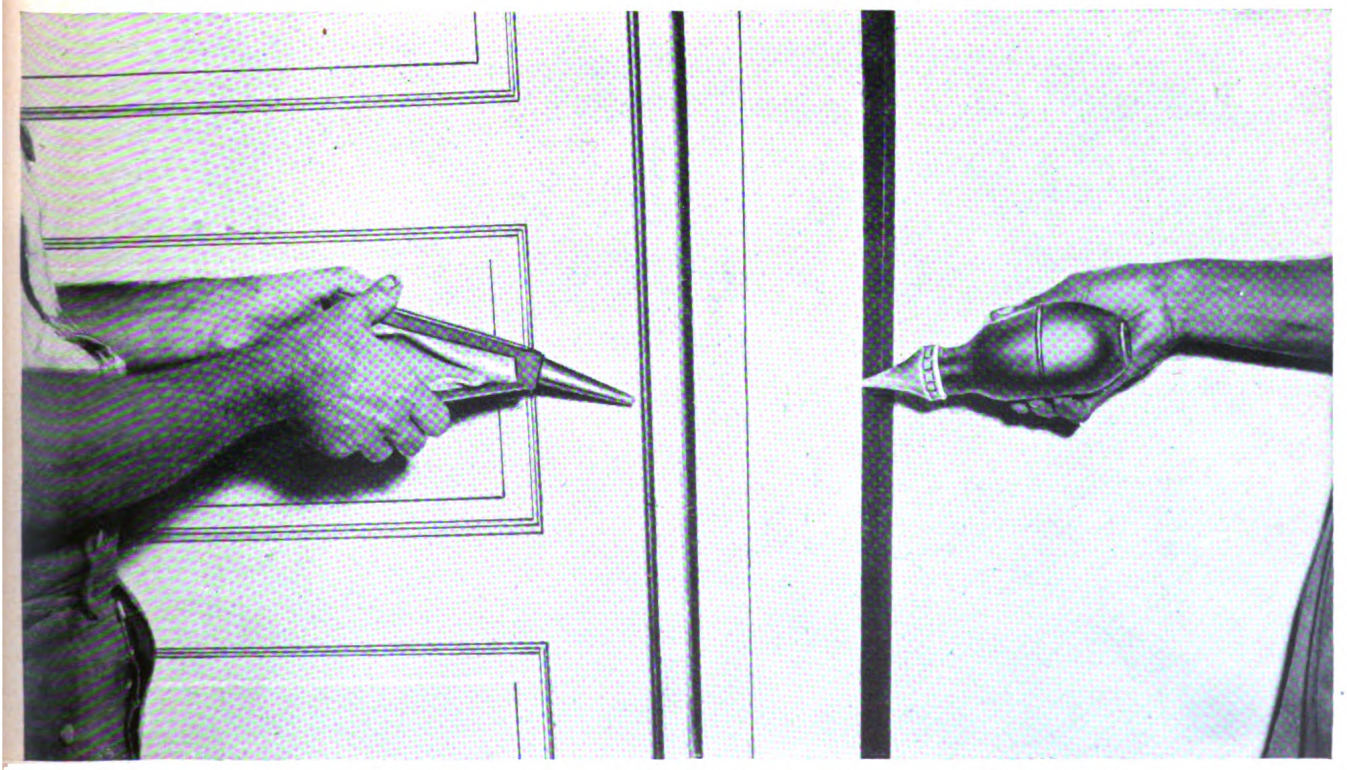


Figure 75. Application of DDT dusts with bellows duster for cockroach control.

CHAPTER 13
ANTS

55. General

Ants that infest Army posts include the Argentine ant, the black ant, and the harvester ant. (See figs. 76, 77, and 78.) They infest mess halls, bakeries, barracks, storage warehouses, and other buildings. The harvester ant destroys valuable grass or other

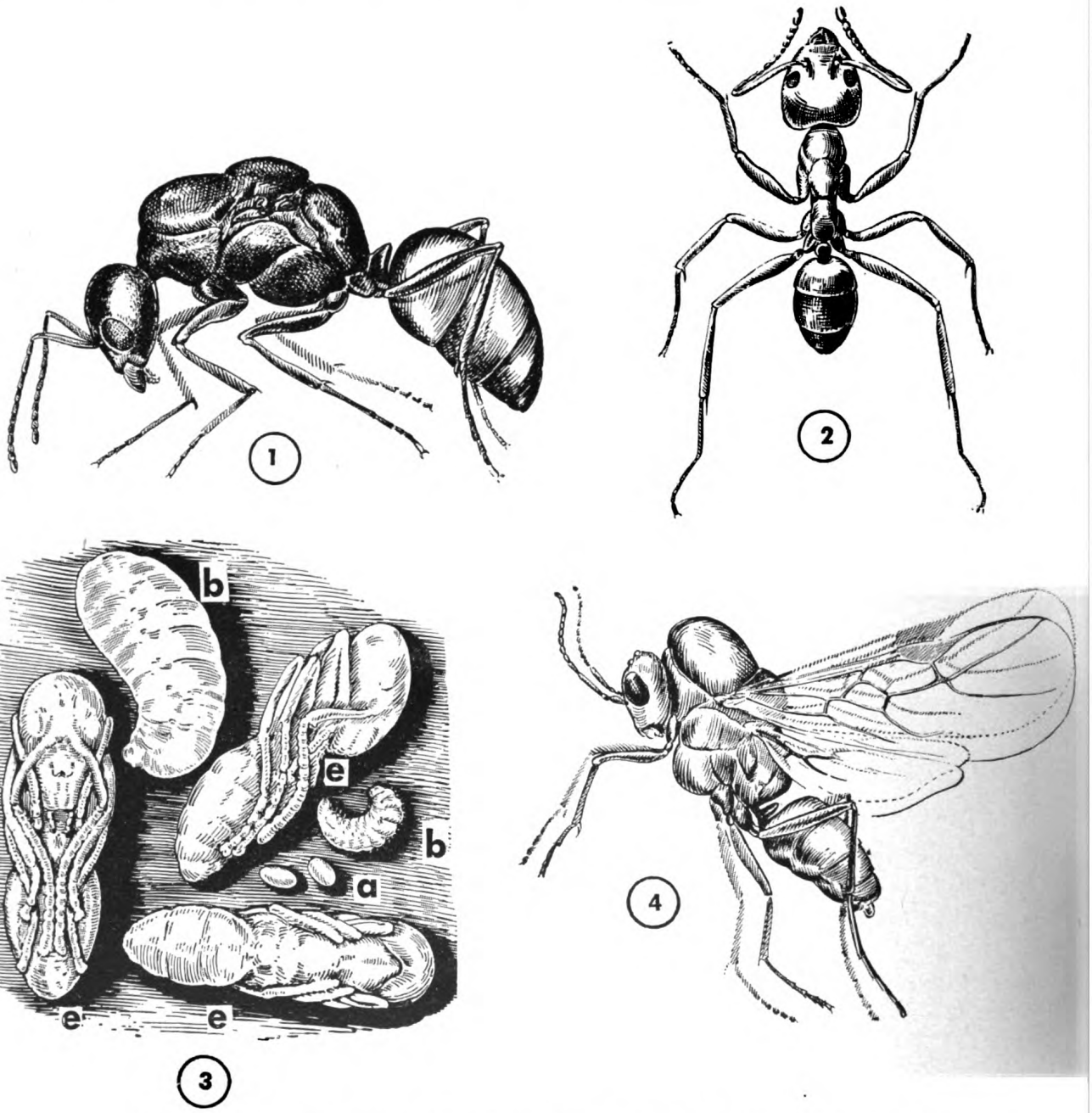


Figure 76. Argentine ant: 1, female; 2, worker; 3, eggs and other stages; 4, male.

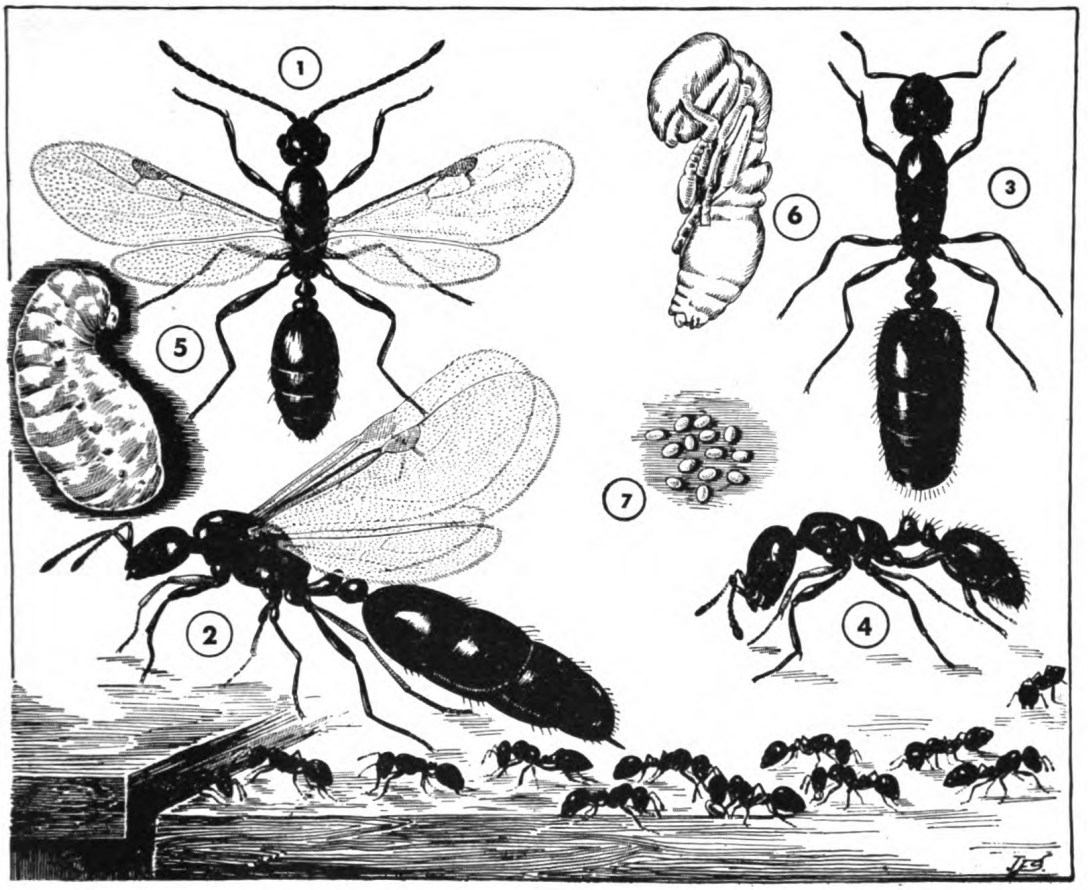


Figure 77. The black ant; 1 and 2, winged king and queen; 3, queen after losing wings; 4, female worker ant; 5, larva; 6, pupa; 7, eggs laid by queen.

Figure 78. Damage by red harvester ant.

vegetative cover and causes a serious problem at airfields and hospitals where such cover is important.

56. Control

DDT sprays and dusts, poison baits, and fumigation of nests are used for ant control. (See fig. 79.) DDT sprays and dusts are so effective that other control measures are not likely to be recommended.

a. DDT Sprays and Dusts. Ants are controlled effectively by 5 percent DDT in kerosene or 10 percent DDT dust. The residual spray or dust is applied to ant nests, window sills, steps, door sills, baseboards, and other places ants use as runways. A coarse wet type spray at the rate of about 1 quart for 250 square feet is applied. Ant hills on lawns, grassplots, or open ground are sprayed with residual DDT spray at the same rate. The DDT dust is applied lightly with a plunger type duster. The dust is less desirable than residual spray because it often is removed by cleaning. However, dust can be blown back into crevices through which the ants are entering where the spray may not penetrate. Kerosene solutions of DDT may kill grass, and care should be exercised in their use on grassed areas.

b. Fumigation. When ant nests outdoors are located, the entire colony can be destroyed by fumigation. The red harvester ant is controlled by calcium cyanide (QM stock No. 51–R–460 Rodenticide Fumigant Dust). Openings into the nests are probed about 6 to 10 inches deep and about 1 tablespoonful of calcium cyanide is placed in the hole, which is capped immediately. All recommended precautions should be observed in the use of this fumigant.

c. Poisons. Poison baits may be used for ant control when other control measures are not available. Effective bait formulas include the following:

(1) Dissolve 4 ounces of sugar in 1 quart of water and stir in ½ ounce of tartar emetic.

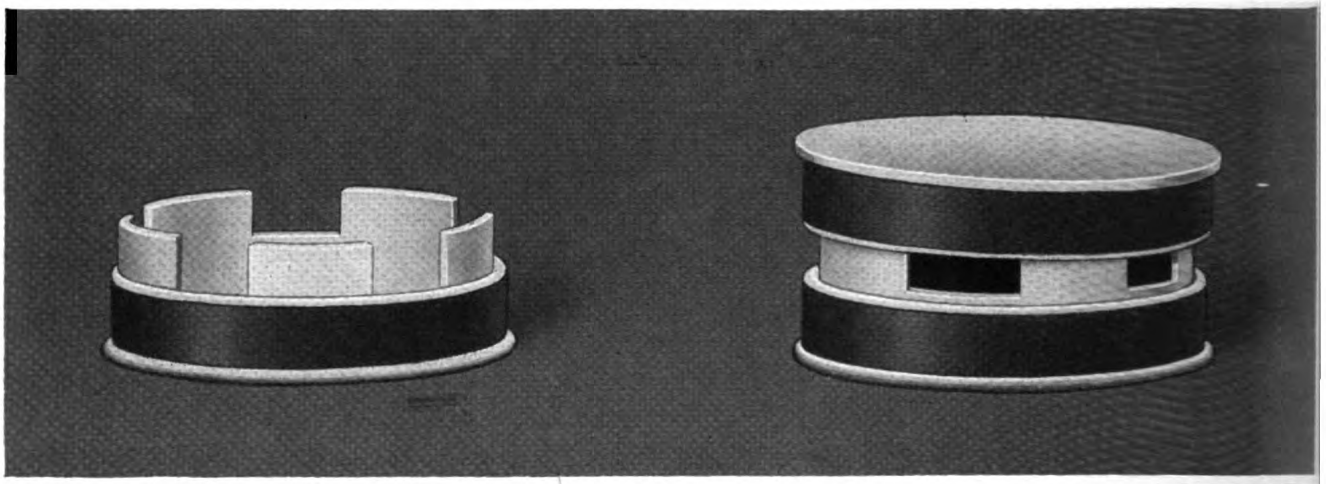


Figure 79. Pillbox for liquid baits for ants. 1, box with sides cut and lid removed; 2, box dipped in hot paraffin and ready for use.

(2) Dissolve ½ pound of sugar in 1 pint of hot water and add ⅐ ounce (62.5 grains of sodium arsenate; bring to a slow boil and strain.

(3) For the Argentine ant, the following is recommended: Mix 9 pounds of granulated sugar, 6 grams of crystallized tartaric acid, and 8.4 grams of benzoate of soda in 9 pints of water; boil the mixture slowly for 30 minutes and allow to cool. Dissolve 15 grams of sodium arsenite in ½ pint of hot water, and allow it to cool. Mix these liquids together and stir well. Then add 1¼ pounds of strained honey and mix thoroughly.

(4) For ants that prefer grease and meat to sweets, work small quantities of tartar emetic into grease or pieces of bacon rind. Extreme care should be taken in using these poison baits.

CHAPTER 14
STORED-PRODUCT INSECTS

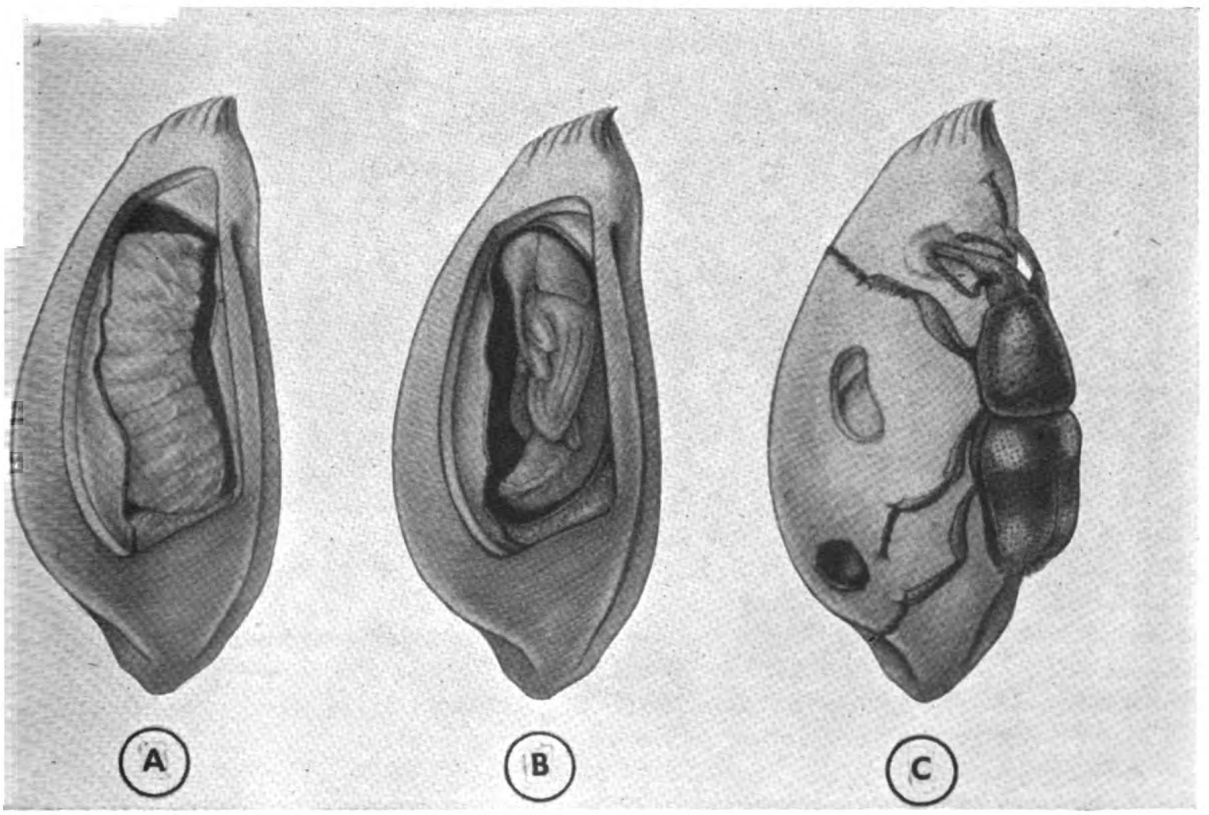
57. General

A number of species of small beetles and moths attack Army subsistence supplies such as grain, meal, rice, oatmeal, breakfast cereals, peas, beans, and dried fruits. (See figs. 80, 81, and 82.) The principal pests are the bean weevils, pea weevils, flour beetles, and grain and flour moths. In addition to the amount of food actually eaten, much of it is contaminated and rendered undesirable for human consumption. Such fabrics as woolen goods and fur-lined equipment are subject to insect attack by clothes moths and carpet beetles. Most of these pests occur in all temperate and tropical parts of the world and may become serious pests in dry food products or clothing stored for more than a few months.

58. Control of Pests of Subsistence Supplies

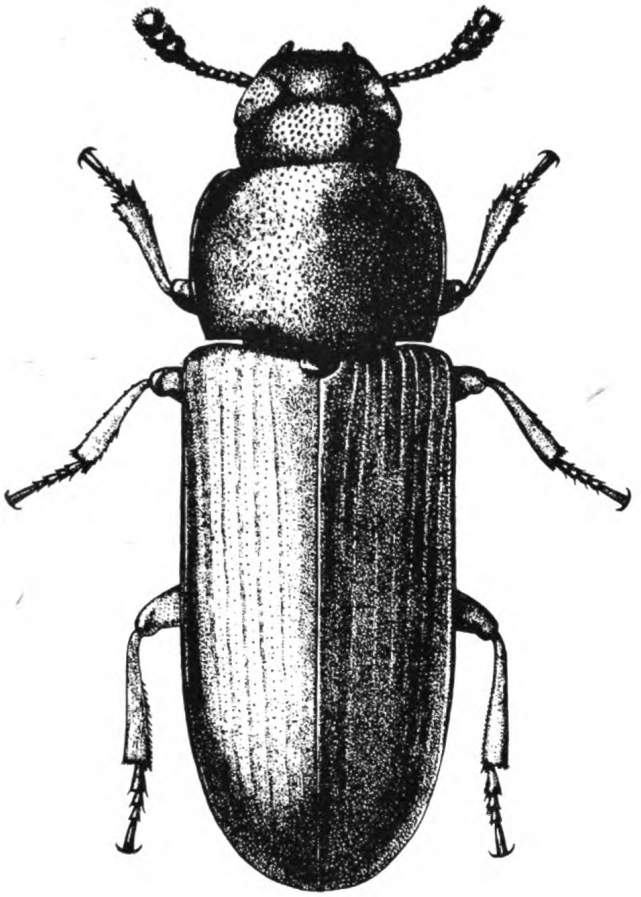
Protective measures for the control of pests of subsistence supplies include purchase of insect-free products, short storage periods, good housekeeping in warehouses, cold storage, insectproof containers, and fumigation. (See figs. 83 and 84.)

a. Purchase of Insect-Free Products. Food products for Army use should be inspected at time of purchase to insure that no infested material is placed in storage. The food-processing plants handling Army contracts should also be

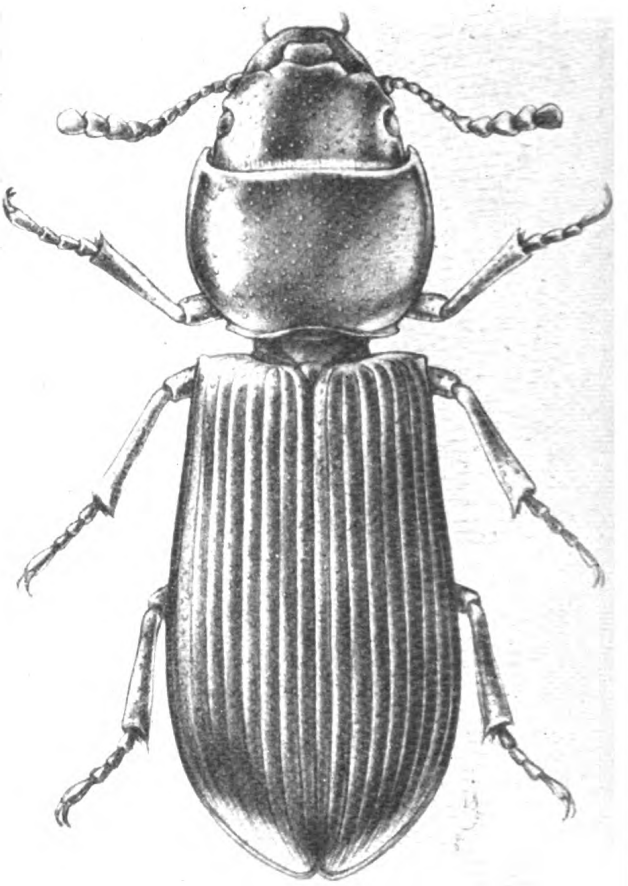


① *Rice weevil: A, larva; B, pupa; C, adult weevil.*

Figure 80.



② *Rust red flour beetle, adult.*



③ *Cadelle beetle.*

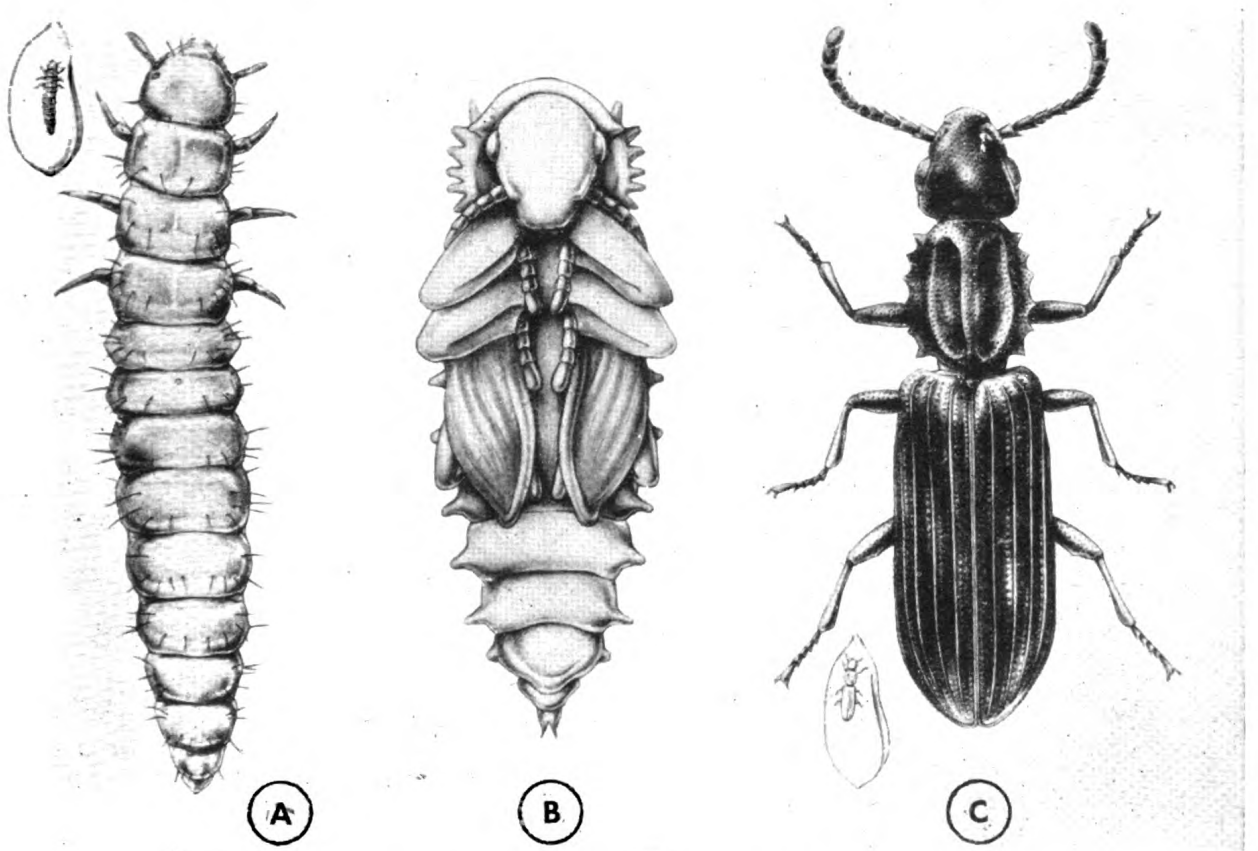
Figure 80—Continued.

inspected periodically. Infested foods should be rejected until placed in a satisfactory condition for shipment. Food contracts should stipulate that all deliveries be free of insects and that food-processing plants maintain a high degree of insect sanitation.

b. Short Storage Periods. Storage periods for Army supplies should be short. Small infestations of weevils and moths may develop large, destructive populations within a few months. Most of the pests involved complete a generation of insects in about 6 weeks at temperatures of 65° F. or above. Supplies of stocks subject to infestation are kept as low as possible and old stocks should be moved first for consumption. Old stocks damaged by infestation may reinfest other goods located nearby.

c. Good Housekeeping in Warehouses. In depots and warehouses where food or clothing is susceptible of infestation, sanitation should be rigidly observed. Small accumulations of food materials in cracks and crevices of warehouse floors support small infestations that carry over until new stocks are moved in. Broken containers, torn sacks, or other spillage about the warehouse should be removed promptly. Cereal products intended for human food should not be stored near infested animal feeds. Insect infestation in warehouses of concrete or brick construction is more easily controlled than in other types of buildings. Goods returned to depots for salvage are often infested and should be fumigated before being carried into warehouses to infest clean stocks.

d. Cold Storage. Storage pests are inactive at temperatures of 50° F. or below. Temperatures in warehouses of food stocks should be kept as low as



④ *Saw-toothed grain beetle; A, larva; B, pupa; C, adult.*

Figure 80—Continued.

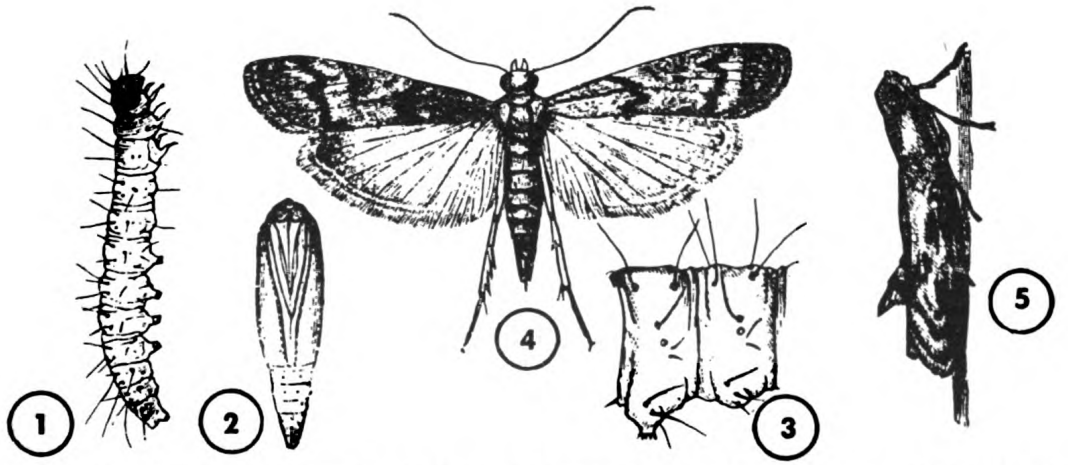


Figure 81. The Mediterranean flour moth; 1, larva; 2, pupa; 3, segment of larva; 4, adult moth; 5, moth in resting position.

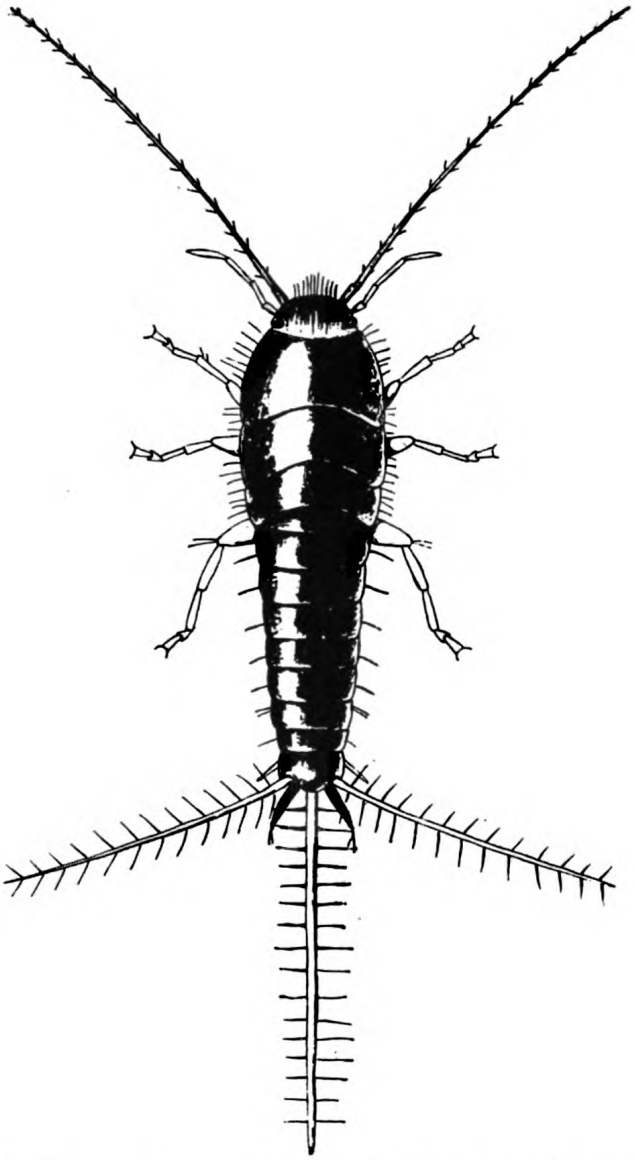


Figure 82. The silverfish, a pest of stored commodities.

possible in winter without freezing the perishable goods. Artificial cold storage is used when available to kill out or to prevent the increase of small infestations.

e. Insectproof Containers. Tightly sealed cartoons, reinforced paper bags, or fabric bags with paper liners protect flour and other foods from becoming infested in transit and in temporary storage. Few insects can gain admittance to properly sealed packages.

f. Fumigation. A system of fumigation should be developed for depots and warehouses to kill incipient infestation in food products shipped out. The apparatus installed for this purpose should also be available to treat incoming salvage materials likely to infest warehouse stocks. Vacuum fumigation is recommended for depots and warehouses because it does not interfere with normal warehouse management. For further discussion of fumigation, see chapter 15. Fumigation programs should be approved by service command headquarters and carried out only by specially trained, experienced personnel.

59. Control of Pests of Cured Meats and Cheese

Hams, bacon, other cured meats, and cheese are subject to infestation by larder beetles, hide beetles, red-legged ham beetles, cabinet beetles, cheese skippers, and cheese mites. (See fig. 85.)

a. Good Housekeeping. In the control of insect pests of meats, cleanliness and good warehouse sanitation are essential. This includes proper disposal of trimmings, scrubbing of floors and warehouse equipment, and frequent changes of sawdust on floors. Insects can develop on small accumulations of trimmings which are often the source of infestation in storage stocks. Cheese mites develop rapidly in these small accumulations of food.

b. Cold Storage. Storage at temperatures below 50° F. arrests development of infestations already present and prevents further insect damage in storage. Mites are killed at 30° F. in 10 to 12 days. Cheese mites feed and develop slowly in storage at 37° to 40° F., but other pests of meat and cheese are inactive at these temperatures. Refrigeration reduces insect damage and prevents contamination by insects.

c. Fumigation. Cured meats are fumigated with hydrocyanic acid gas in accordance with Federal regulations, when the fumigation is approved by Federal meat inspectors. All fumigation programs should be approved also at service command headquarters before work is begun. Dosage of 1 pound of liquid hydrocyanic for each 1,000 cubic feet is recommended with 24-hour exposure. Directions for fumigation are given in chapter 15.

60. Control of Fabric Pests

Army supplies made of wool, mohair, furs, or bristles are subject to attack by clothes moths and carpet beetles. Items most likely to be attacked are woolen uniforms, blankets, wool and fur-lined helmets, boots, gloves, sheepskin-lined harness and saddles, animal-fiber brushes, carpets, and upholstered furniture with animal-fiber covers.

a. Preventing Injury. Damage may be pre-

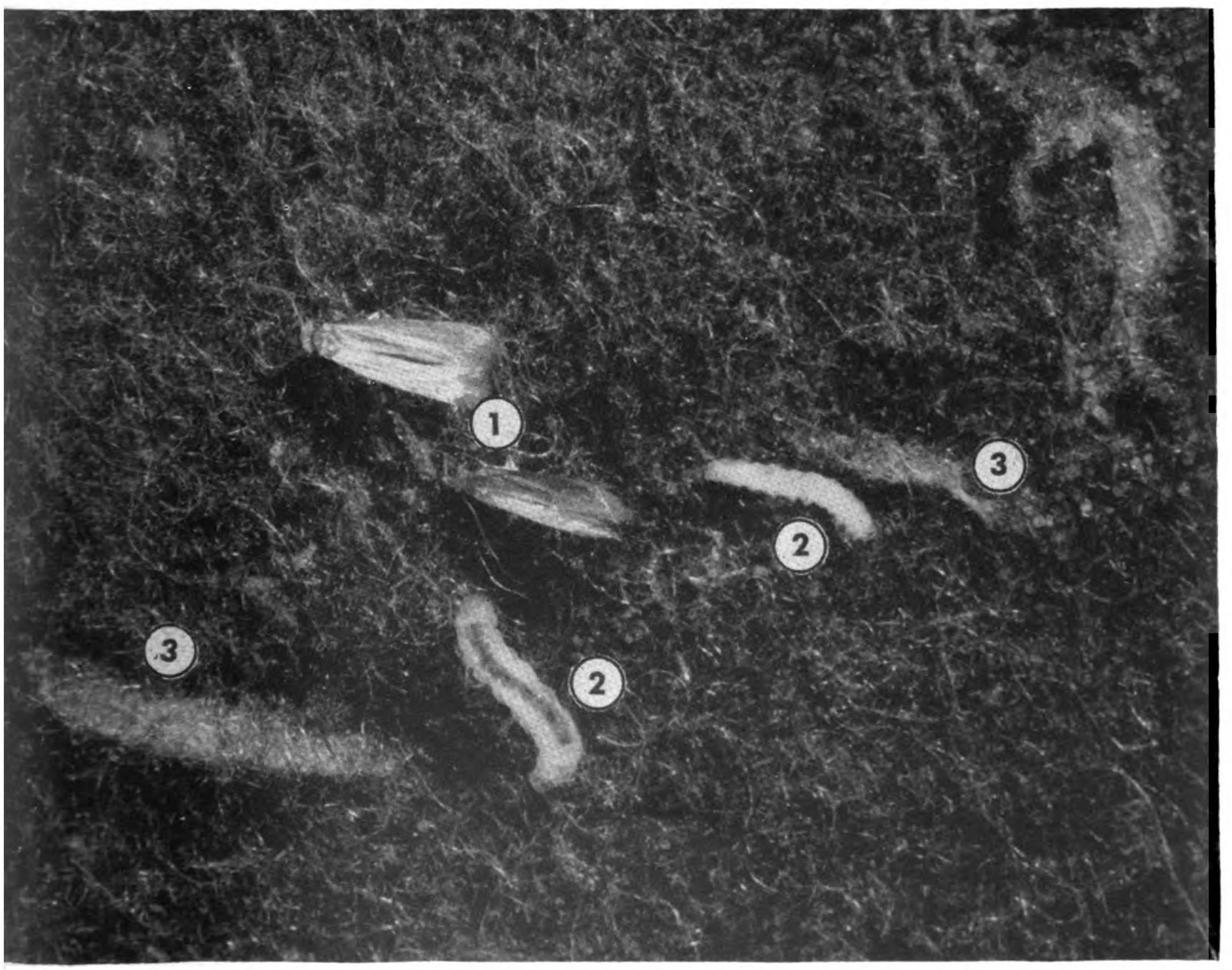


Figure 83. Webbing clothes moths: 1, adult; 2, larvae; 3, silken tunnels.

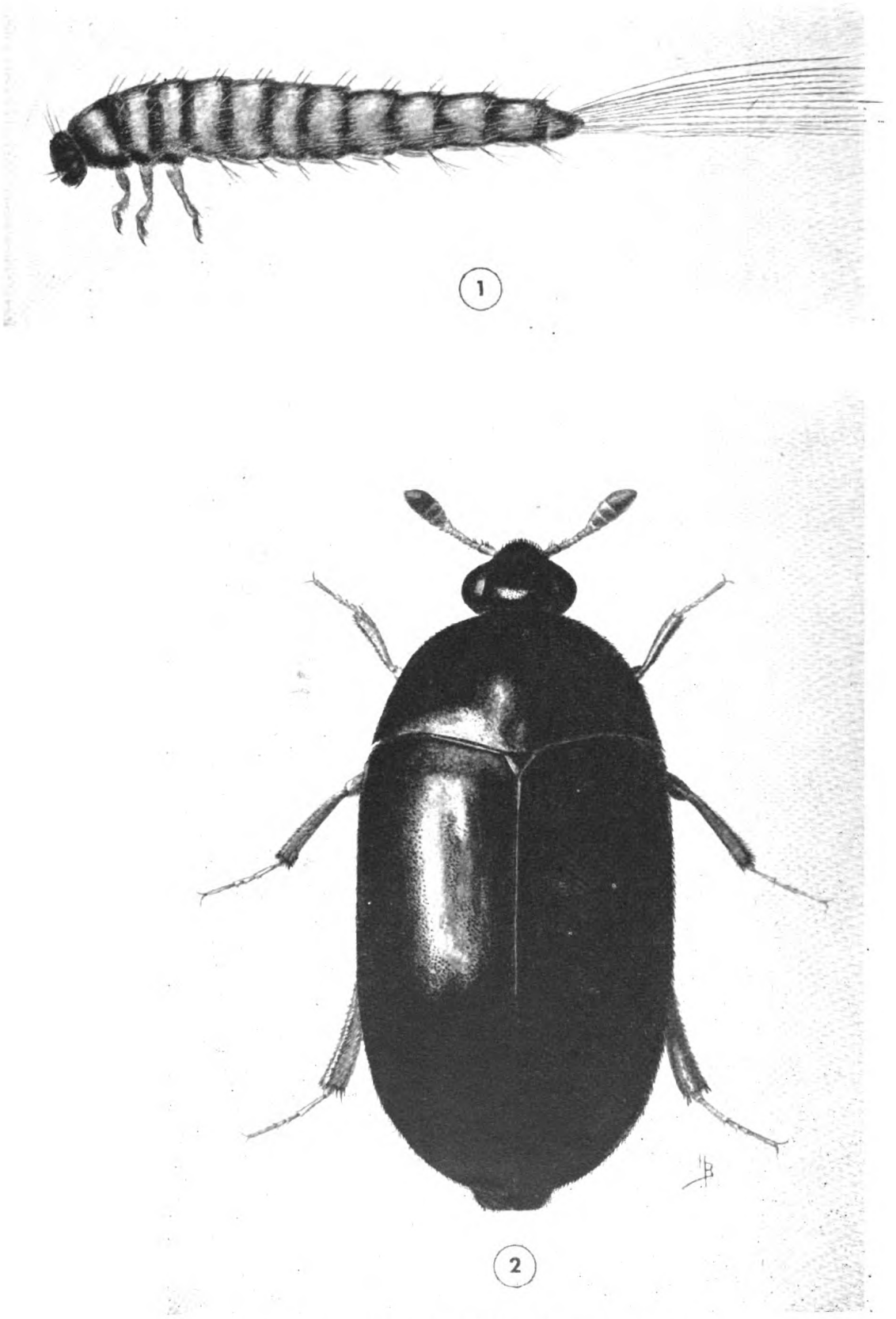
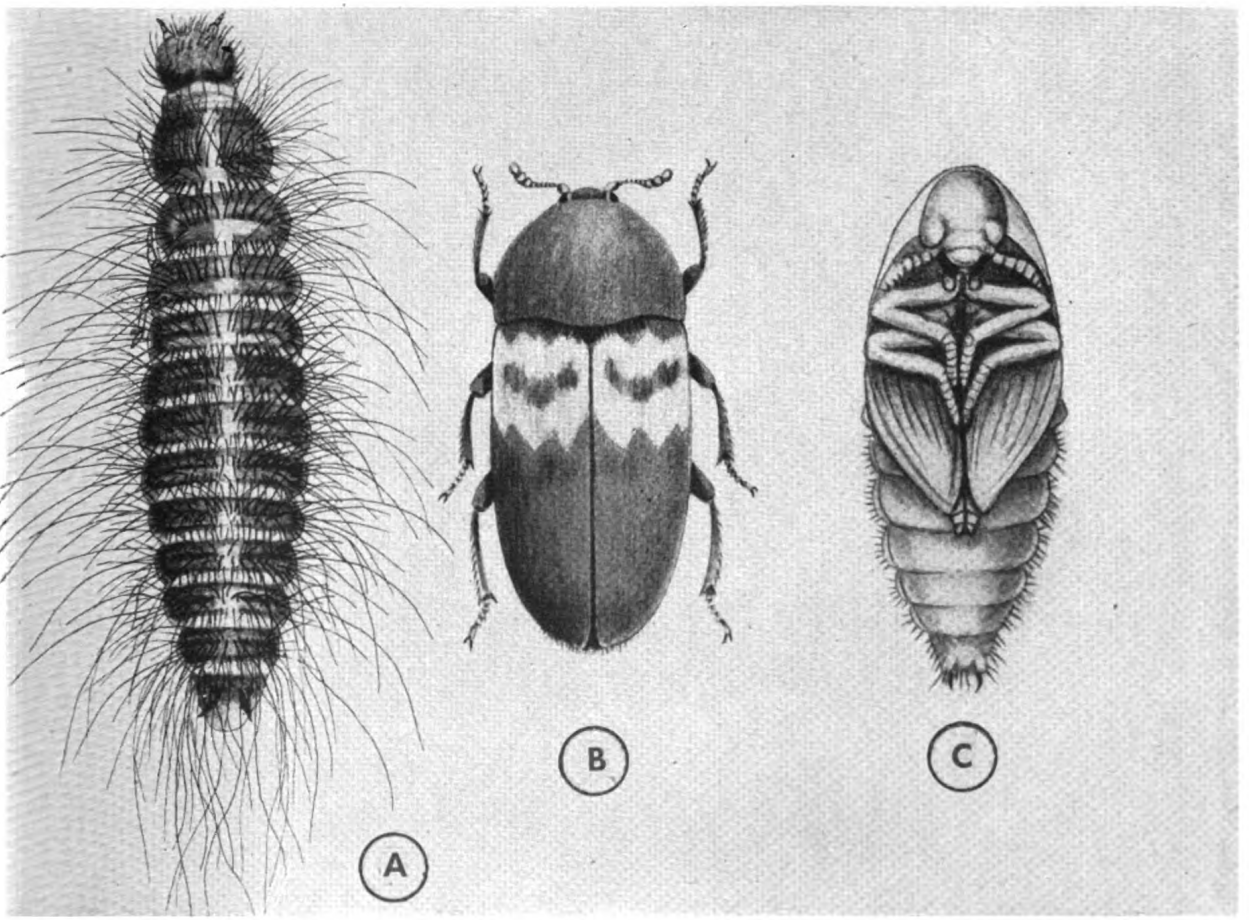


Figure 84. Black carpet beetle; 1, larva; 2, adult.

vented in stored fabrics by mothproofing and by use of flake naphthalene or paradichlorobenzine. Mothproofing of fabrics and furs should be carried out during the manufacturing process. Crystals of flake naphthalene or paradichlorobenzene are sprinkled among stored items subject to fabric insect attack. From 1 to 2 pounds for each 100 cubic feet of storage is an effective dosage. Storage rooms must be kept closed and airtight.

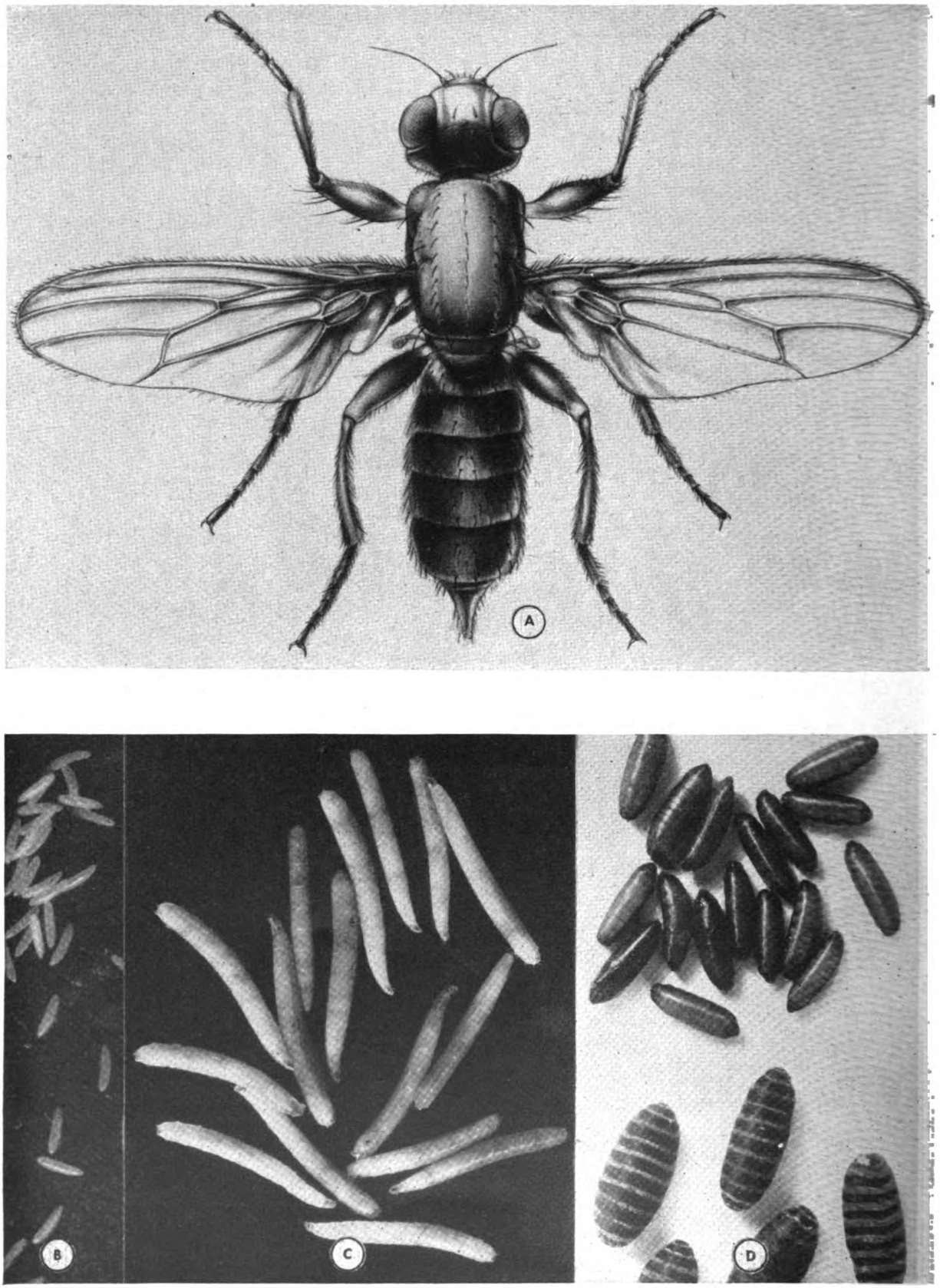
b. Cold Weather. Winter weather can be utilized to reduce or eliminate clothing or other fabric pests. Activity and damage ceases at temperatures below 50° F.; moth larvae are killed in 1 to 2 days at zero temperatures. In many parts of the country, however, winter temperatures are not low enough to be effective.

c. Fumigation. In modern storage warehouses, fabrics stacked in the bags can be fumigated with hydrocyanic acid gas. Only experienced personnel are used for this work. The effectiveness of the fumigation depends upon the method of crating, packing, and stacking of the fabrics. All safety requirements enumerated in chapter 16 are used. In loosely constructed warehouses, a storage space that can be fumigated is provided inside the warehouse or on the loading platform. Assistance of the service command headquarters should be obtained in installing these chambers.



① *The larder beetles; A, larva; B, adult; C, pupa.*

Figure 85.



② *Cheese skipper.*

Figure 85—Continued.

CHAPTER 15
FUMIGATION

61. General

Fumigation is an effective means of exterminating insects and rodents inside buildings or other inclosures that can be made relatively airtight. Execution of the work, which is the responsibility of the Corps of Engineers, generally includes application of fumigants in storage warehouses, gastight fumatoria, or vacuum-fumigation chambers. (See fig. 86.) Fumigation is also done under tarpaulins impervious to gas and in disinfestation bags. This work is carried out by trained post engineer personnel authorized by service command headquarters. At ports of embarkation, disinfestation plants are constructed primarily for delousing Army personnel and prisoners of war. These plants are designed by the Corps of Engineers and the Medical Department and procured by the Quartermaster. The apparatus is installed by the Corps of Engineers and post engineers assist with its operation.

62. Building Fumigation

Gases most commonly used in Army fumigation are hydrocyanic acid gas and methyl bromide. Hydrocyanic acid gas is used for stored-product pests and rodents; methyl bromide is used to delouse clothing. The hydrocyanic acid gas is applied in the form of discoids, liquid hydrocyanic

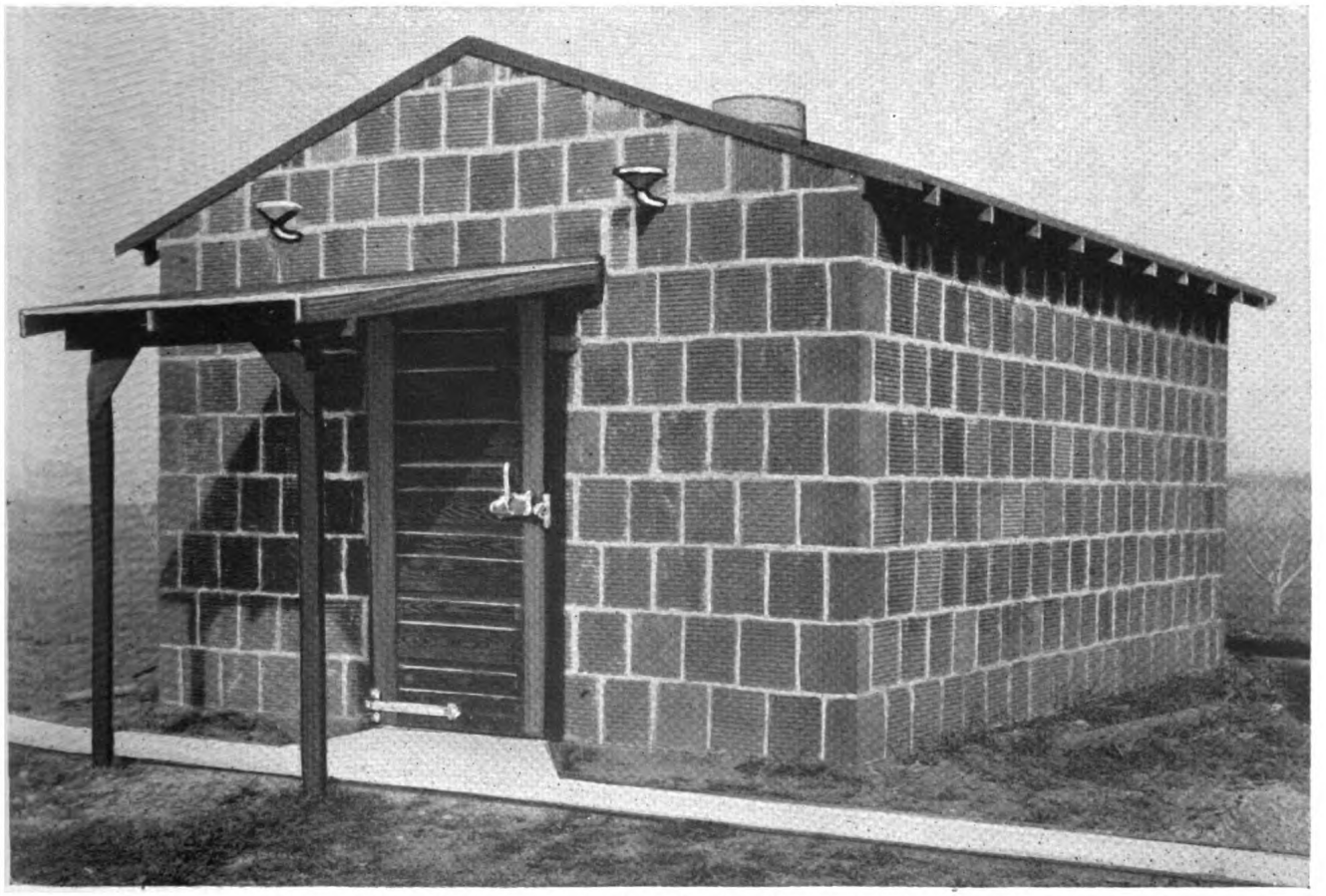


Figure 86. Outdoor fumatorium for treating infested materials.

acid, or calcium cyanide; it does not corrode Army equipment and most foods are not subject to contamination from its use. Having a wide range of application, it is safely applied by qualified and trained personnel. Definite conditions to be met before building fumigation is begun include training of fumigators, protection of building and surroundings, and observance of the recommended

command. Each man is equipped with a properly fitted gas mask and canister to protect against inhaling gas. For discoid fumigation, one man opens the can, another scatters the disks, and the third is an observer. After the gas is released, no fumigators may enter the building alone or become separated from one another inside the building until tests show that entry can be made safely

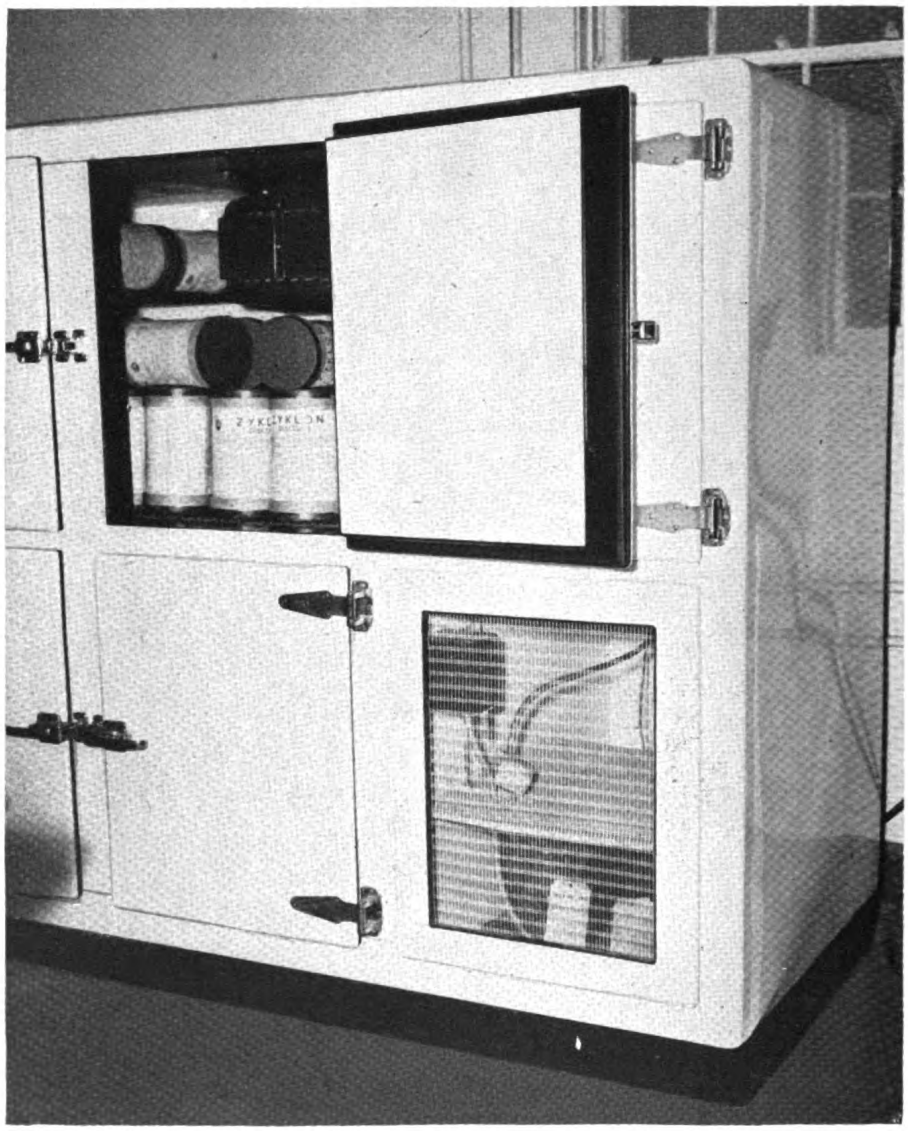


Figure 87. Precooling hydrocyanic acid discoids.

safety precautions. The fumigation of mess halls and barracks is not recommended when DDT is available.

a. Fumigators. Intelligent, dependable men in good physical condition are selected for training as fumigation teams. Three men are trained for each team under the direction of the service

without a mask. *This is of cardinal importance.* (See figs. 87 and 88.)

b. Preparing the Buildings. In preparing warehouses or other buildings for fumigation, all doors except the exit are closed and sealed from the outside, but they should not be locked until after the gas has been released. The exit door is

① *Opening discoid can for space fumigation.*

② ***Three or more men, trained and fully equipped, constitute a fumigation team.***

Figure 88.

also sealed from the outside after the gas is applied. Windows and other openings are closed from the inside, window sashes being made tight with props and wedges. Broken glass is replaced and cracks or other openings through walls repaired. Openings around poorly fitted doors and windows are covered with oiled or coated paper impervious to gas or with kraft paper having a thick coating of cup grease. Gummed or marking tape may be used effectively to seal around window sashes and door frames. Ceiling vents may be sealed with tight-fitting wood covers or tar paper. Chimney vents, roof ventilation, and attic louvres are sealed from the outside with tar paper or other available gastight materials.

c. WARNINGS. (1) Warning signs, 14 by 18 inches, are placed on each door at about eye level, lettered conspicuously with red letters on a white background as follows: *Cyanide gas fumigation deadly poison; government-issue masks not effective: keep out; by order of Commanding Officer.*

(2) Doors should be barricaded, in addition to being locked, by fastening a board securely across the doorway at level of warning sign. The warning sign may be painted directly on the barricade board.

(3) Guards are posted around the fumigated building before the release of gas to prevent unauthorized persons from approaching or entering. (See fig. 89.) All persons, including guards, should remain at least 20 feet from the fumigated building until it is fully aerated and released.

(4) All buildings are thoroughly inspected and loud vocal warnings are issued just before releasing gas to make sure no occupant remains within.

Figure 89. Guards stationed on duty from period just prior to release of gas until building is aerated and released for occupancy.

d. MASKS. The Army service gas mask M1A2 with special HCN canister is used for hydrocyanic acid gas. Masks are fitted with special canister for methyl bromide when this gas is used. Elastics are adjusted so mask fits tightly and prevents twisted straps or unequal stresses producing a poor fit. Crew wears gas masks during release of gas in buildings, during unsealing, and while testing to determine that aeration is complete.

Masks should be tested thoroughly for leaks before each use.

e. Dosage. Dosage rates of HCN are from 6 to 16 ounces of hydrocyanic acid to 1,000 cubic feet. Dosage depends on the material fumigated and the penetration desired. Such spaces as empty buildings or those filled with loosely stacked impervious materials, which require little penetration, need only a 6-ounce dosage. Stored products such as beans, peas, rice, dried fruit, and cured meats require larger dosages up to 16 ounces of HCN for 1,000 cubic feet. Dosage rates used for all materials should be approved by service command headquarters.

f. Applying Discoids. Application of discoids is made after space to be fumigated is fully prepared. The cans of discoids are distributed at points where they are to be opened and scattered. After all preparations are complete, the following procedure is followed:

(1) See that all doors except exit are sealed.
(2) Check fit of masks on operators.
(3) Post guards outside buildings.

Figure 90. Discoids of HCN distributed in building fumigation.

(4) Make final inspection to determine space has been vacated.
(5) Open cans farthest from exit and work towards door. (See fig. 90.)
(6) Do not retrace steps over space containing scattered discoids.
(7) Work rapidly but do not hurry or become excited.
(8) Avoid touching discoids with bare hands; shake them from cans.

(9) See that all men of fumigation crew leave building together.

(10) Close and lock exit door. (See fig. 91.)

(11) Place barricades and warning signs across doors.

g. Length of Dosage. Dosages of HCN are allowed to remain in treated spaces for 6 to 72 hours, depending on the penetration required. Warehouses filled with materials having high density require as much as 72 hours exposure while buildings with loosely packed materials are fumigated in 6 hours.

h. Clearing Building. The gas is aired out at the end of the fumigation period; gas masks are worn during opening of building and all inspections for gas. Outside ventilators, when available, are opened first followed by a door opposite the windward side of building and then by all other doors on the first floor. Allow 15 minutes to elapse before entering the building to open all windows, louvres, ventilators, or other openings to accelerate air circulation. Small buildings or those containing only household goods may air out in 1 to 2 hours while large structures require 12 to 72. Tests must be made with methyl orange test papers for presence of HCN. Possibility of gas pockets occurring where ventilation upward is poor must be kept in mind. Test papers are obtained from the manufacturers of hydrocyanic acid. Directions for use of paper accompanying each order of gas must be followed for effective use.

i. Disposal of Discoids. The spent HCN discoids are gathered up after exposure and burned or disposed of as trash. They contain no hydrocy-

Figure 91. Exit door locked and sealed and warning signs.

anic acid and are safe to handle. Liquid HCN applied from steel cylinders leaves no residue behind after fumigation.

63. Chamber Fumigation

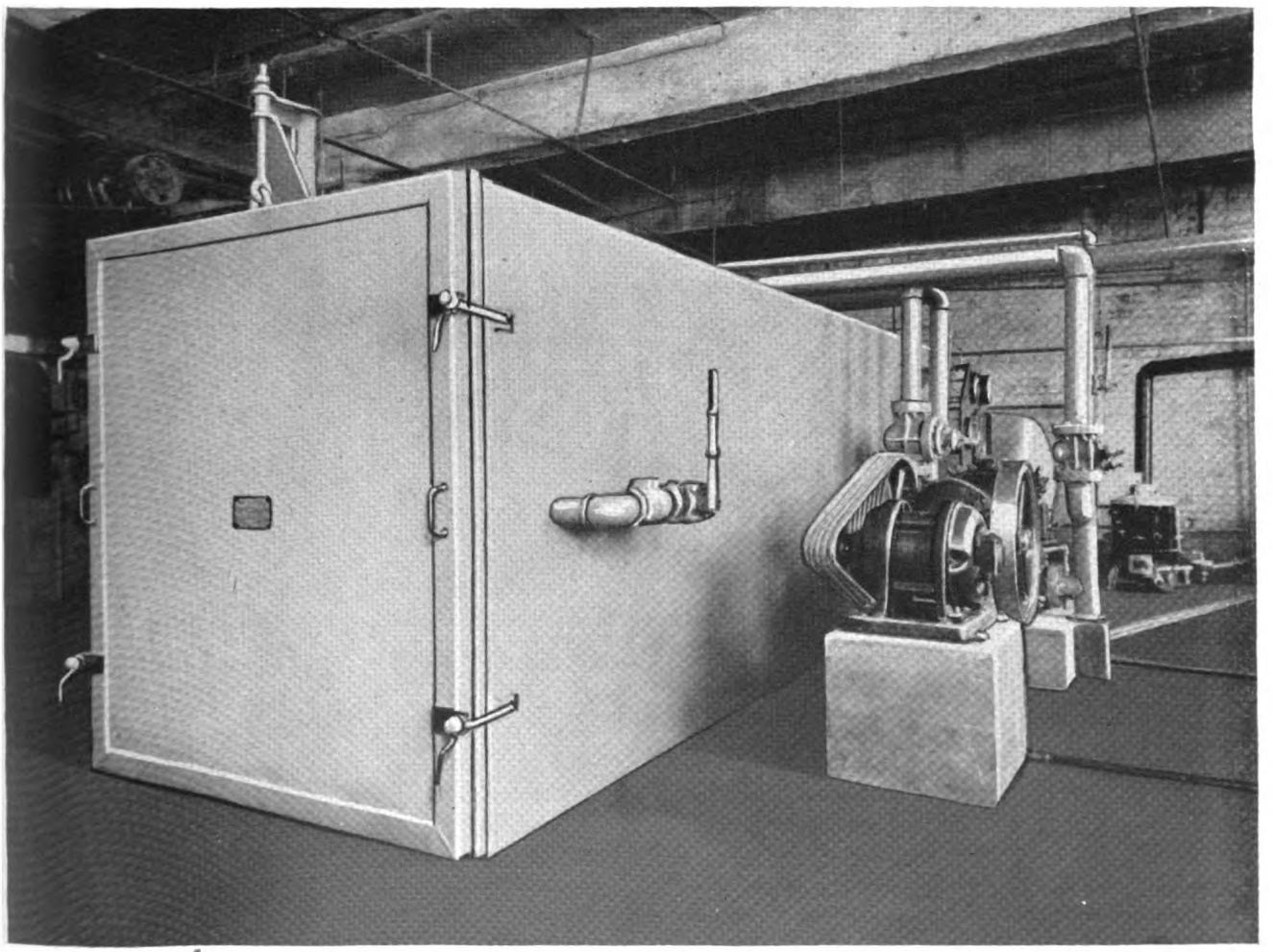
Gastight vaults or chambers with exhaust fans are used to fumigate stored food products and clothing. They are constructed of any gastight materials. Posts desiring to construct a chamber should request technical assistance of service command headquarters. Operators of fumigation chambers are selected and trained for the work the same as building-fumigation crews.

a. Procedure. Materials to be treated are loaded into chamber and stacked so at least 4 inches of free space remains between goods and wall. Separation strips are placed between layers of stacked material to permit circulation of the gas. When the chamber is fully loaded, doors are closed, sealed locked, and proper dosage of fumigant is applied for 24 to 36 hours of exposure. Gas is removed from chamber with exhaust fan after fumigation. Treated chambers and contents are thoroughly aerated before unloading is done.

b. Dosage. Liquid HCN, generally used in chamber fumigation, is applied with an applicator supplied by the manufacturer, or through a piping system with outside connections. Dosage ranges from 16 to 24 ounces for each 1,000 cubic feet of space treated. The exact dosage is determined by the density of the materials treated and time available for exposure. Dosage rates for hydrocyanic acid or other fumigants should be approved by service command headquarters.

64. Vacuum Fumigation

Vacuum chambers are constructed of steel plates in sizes to accommodate the desired volume of goods. (See fig. 92.) Such chambers are recommended for permanent Army depots and warehouses to



① *Metal vacuum chamber for small-scale fumigation of Army subsistence supplies and clothing.*

Figure 92.

treat outgoing lots of infested material or incoming goods for salvage or storage. Effective control of insects is possible with exposures as short as 1 hour. Goods are rapidly aerated by air washing, increasing the output of fumigated goods by each chamber. This apparatus is required also for lots of goods that may become infested during the storage period.

b. INSTALLATION. When installations of vacuum chambers are desired, technical assistance is obtained from service command headquarters, since this specialized apparatus requires careful design to treat individual needs. It is installed at proper locations to accommodate the needs of depots and warehouses. Engineering facilities of manufacturers of vacuum apparatus are available

③ *Large vacuum chambers accommodating about two carloads each of Army supplies.*

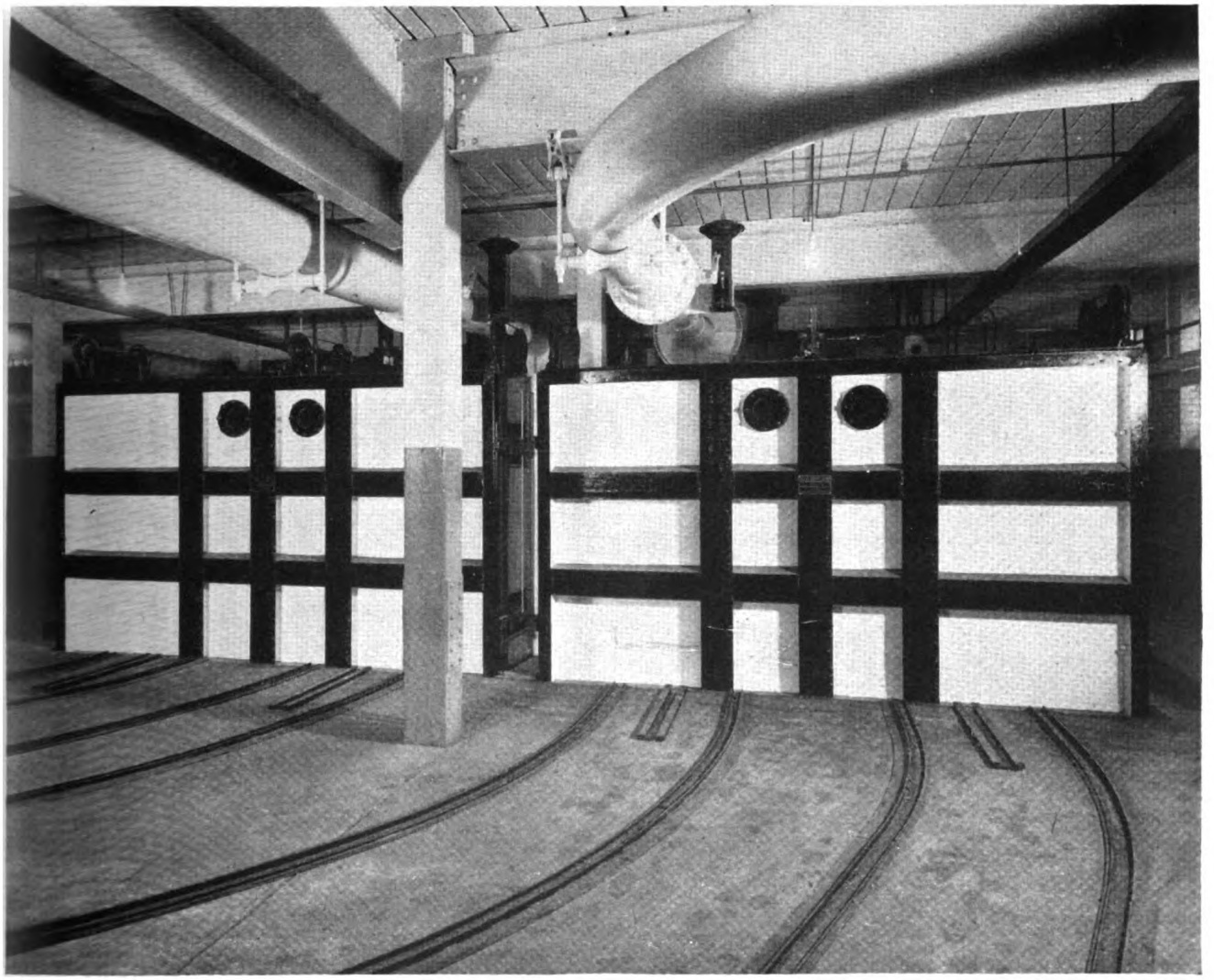
Figure 92—Continued.

a. EQUIPMENT. Necessary equipment for installing a vacuum fumigation plant includes steel tanks of proper size to accommodate volume of goods and types of packages, air pump of proper size to draw a 28-inch vacuum in 10 minutes or less, instrument panel for vacuum gauges, mercury gauge, and recorder, applicator for fumigants, built-in fan to circulate gas, and suitable connections.

in the installation of unit plants. Technical assistance should be obtained for working out operating procedure, dosage rates, and fumigants to be applied.

c. PROCEDURE. In vacuum fumigations, air is pumped from loaded chamber until the pressure is reduced on a gauge to about 29 inches of vacuum. The fumigant is applied with a suitable applicator supplied by the manufacturer of the chamber, and

immediate penetration is obtained in all types of packaged subsistence supplies and clothing. At the end of the exposure, the goods are air-washed by repeatedly drawing a high vacuum and breaking it with air to remove excess gas and permit rapid and safe unloading. Goods are loaded on pallet dunnage and conveyed to and from the chamber with lift trucks.



② *Vacuum chambers designed to treat about one carload of Army supplies.*

Figure 92—Continued.

65. Safety Measures and First Aid for Hydrocyanic Acid Gas

Training of fumigation crews includes emphasis on safety measures and demonstrations of first aid for fumigant used on Army installations. Since HCN is widely used for the disinfestation of subsistence items and clothing, safety recommendations and first aid are extremely important.

a. Safety. Safety precautions include the following:

(1) Adequate training and certification of fumigation crew by service command headquarters.

(2) Observance of post regulations for storage of fumigants.

(3) Notification of the post fire marshal, safety director, and medical officer of the day when buildings are under fumigation.

(4) Maintenance of gas masks, can openers, and methyl orange test papers in satisfactory condition for use.

b. First Aid. First aid is important for

fumigation work and satisfactory tests are passed before men are certified for the work. First aid measures should be demonstrated to fumigation crews as follows:

(1) Person overcome or affected by gas is removed to fresh air as soon as possible.

(2) Prompt attention is given to victim on the spot.

(3) Medical officer is sent for.

(4) Patient is kept warm and at rest, but hot applications are not made.

(5) Patient inhales fumes from an amyl nitrite pearl broken in a handkerchief and held lightly over nose allowing only a slight whiff at intervals of about 1 minute.

(6) If breathing has stopped, artificial respiration is applied by Schaeffer prone-pressure method.

(7) Fumes of amyl nitrite are administered during artificial respiration.

(8) Gas masks are worn during work of rescuing persons from within buildings.

CHAPTER 16
INSECTS ATTACKING GRASSED AREAS

66. General

For protection of grounds and for dust and erosion control large areas at Army posts are often planted in grasses or other suitable vegetation. Trouble by insect pests varies in different parts of the country, depending on such factors as climate, rainfall, and geographical location. The chief pests are Japanese beetles, white grubs, grasshoppers, and mole crickets. When infestations occur, control measures are applied to prevent serious losses.

67. Japanese Beetle

The Japanese beetle has become very destructive since its introduction into this country around 1916 with heavy infestations commonly found at Army installations in the First, Second, and Third Service Commands. The insect damages grasses and other vegetation in both larval and adult stages. (See fig. 93.)

a. Plant Food and Moisture. If grass is kept vigorous, need of artificial control measures is greatly reduced. Neglected land where vegetation suffers from malnutrition and lack of growth is more susceptible to serious damage.

b. Lead Arsenate. Lead arsenate, used successfully for grubproofing grassed areas in Japanese beetle control, is applied at a rate of 10 pounds to 1,000 square feet. The chemical may be mixed with about 25 times its volumes of moist sand, soil, or other suitable material and applied by hand or with a hand-operated fertilizer distributor. Lead arsenate can also be applied as a spray from power sprayers like those used for

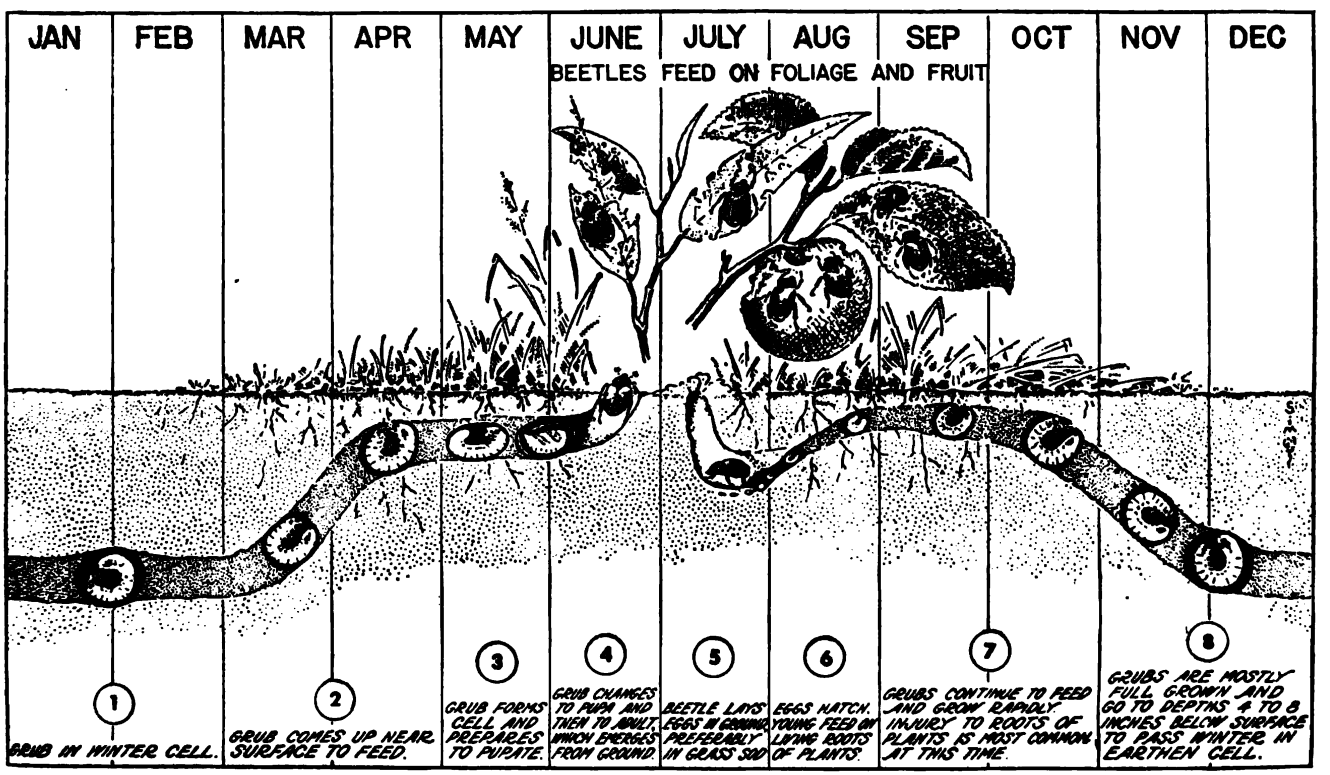


Figure 93. Diagrammatic representation of seasonal life cycle of Japanese beetle.

orchard and shade trees. Applications can be made at any season of the year when the ground is not frozen, but should as a rule be made before July. Immediately after treatment, the ground is raked and watered to wash the poison into the soil. Protection from injury by Japanese beetle grubs may be expected for a period of 5 years following this treatment. Because lead arsenate is poisonous to men and animals, it must be handled and applied with care. Gloves are worn when mixing the chemical and when applying the mixture. Hands must be kept away from the mouth during these operations and then washed thoroughly. Men and animals are barred from treated areas until the lead arsenate has been washed into the soil. Before the treatment of large areas is undertaken, technical assistance of service command headquarters is obtained.

c. Milky Disease. Spores of a disease known as milky disease are incorporated in a dust that may be used effectively against Japanese beetle grubs attacking grassed areas. Since these spores lend themselves readily to field distribution, this biological material may be used in place of lead arsenate treatment. This control method is usually recommended where a substantial grub infestation exists. Spores are propagated in the bodies of grubs and then incorporated into talc as a carrier; this mixture is standardized to contain 100 million spores per gram which produces the desired dosage. When spore-dust treatments are contemplated, post engineers should obtain technical assistance from service command headquarters or from specialists of the U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine. Recommendations of the U. S. Department of Agriculture for applying this dust follow:

(1) A rotary type hand corn planter is used to apply the spore dust. The planter can be adjusted to deliver accurately 2 grams (approximately 1 level teaspoonful) of material for each spot. It holds 1¾ pounds, enough to treat 1 acre when applied at 10-foot intervals.

(2) Where moderate to heavy Japanese beetle grub population occurs, the milky disease organism disseminates throughout a treated area in three seasons if the treated spots are spaced at 10-foot intervals. Although quicker build-up of disease could be obtained if an area were completely colonized with spore dust, excessive quantities of material would be needed for such treatment.

d. Traps. To determine the presence of the Japanese beetle in an area, traps designed to catch adult beetles are installed during the flight period of these insects, in spring and early summer. The trap and chemical used in it are the standard recommended by the USDA.

e. Inspection. Grassed land of Army posts in infested areas are inspected semiannually for damage from Japanese beetle grubs. Dead patches of sod which lift easily in the hand indicate infestation. Where such patches occur, samples of soil are spaded up and examined for grubs.

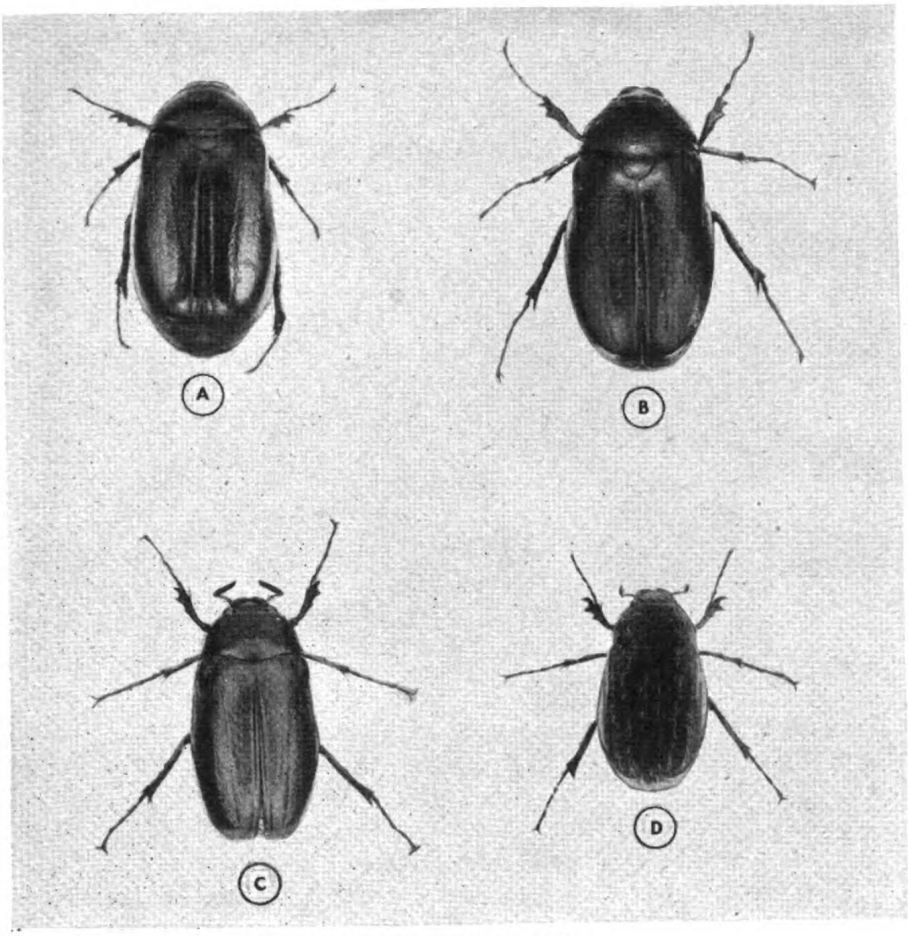
68. White Grub

White grubs are the larvae of May beetles or June bugs. (See fig. 94.) They feed on the roots of grasses and other vegetation in the northern States, the Fifth and Sixth Service Commands being particularly susceptible to injury by these insects. Finding 15 to 20 grubs in a square foot of vegetative cover is not uncommon in this area. White grubs resemble Japanese beetle grubs and have similar habits but are larger and whiter when fully grown. Lead arsenate is applied to grassed areas for white grub control with the identical methods and safety precautions recommended for Japanese beetles. No cases have been reported of poisoning native birds or domestic animals on areas treated with this material.

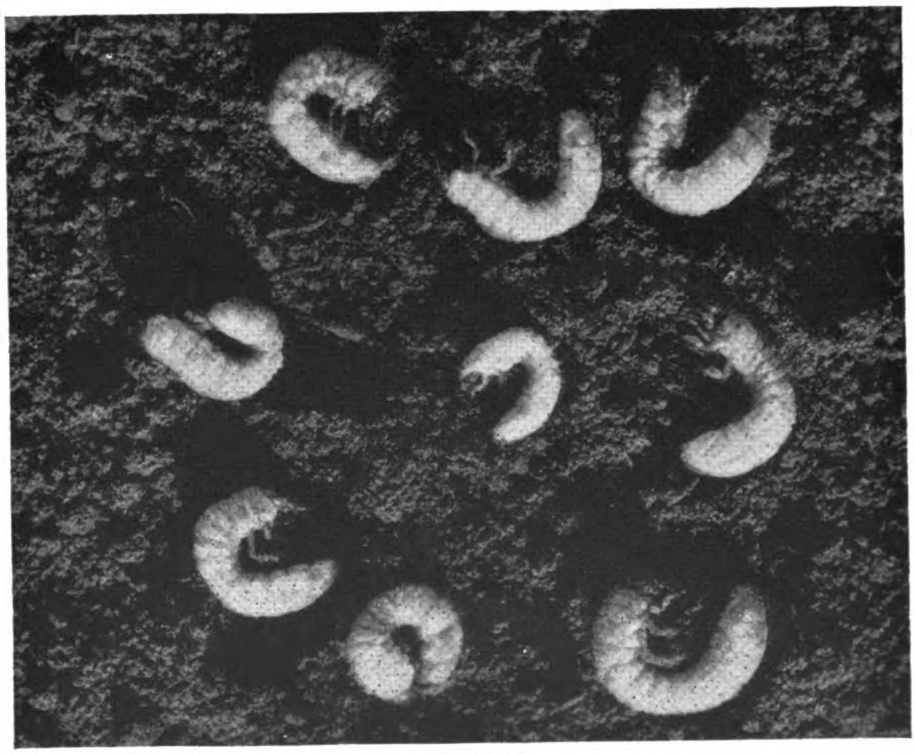
69. Grasshoppers

a. General. Control of grasshoppers is a recurring problem on the grassed areas of Army posts located in many western States, especially in the Seventh, Eighth and Ninth Service Commands. When these insects appear in large numbers, they almost completely destroy vegetative cover over wide areas, leaving the soil unprotected and subject to excessive erosion by blowing and washing. Post engineers should request technical assistance of service command entomologist or nearest specialist of USDA when outbreaks of grasshoppers threaten serious damage to vegetation. (See fig. 95.)

b. Poisoned Baits. Poisoned bait for the destruction of the young and adult stages of grasshoppers is the most practical method for control on Army reservations. The use of bait is simple, reliable, and economical. Bran and sawdust mixtures make the best baits from the standpoint of availability, cost, and relative efficiency.



① *May beetles, adult.*



② *White grubs.*

Figure 94.

③ *Blue grass showing areas destroyed by white grubs.*

Figure 94—Continued.

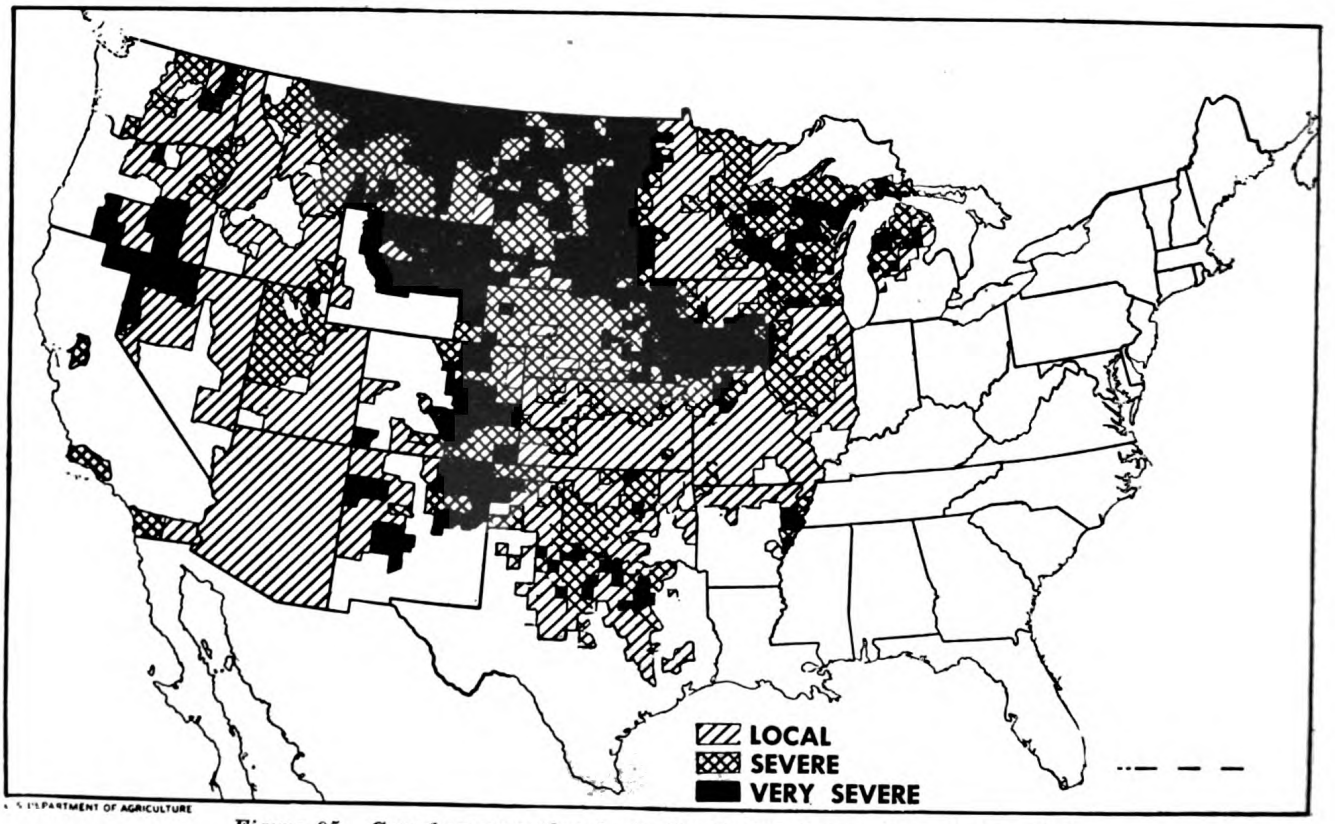


Figure 95. Grasshopper outbreaks in the United States from 1931 to 1938.

(1) *Formulas.* The following bait formulas are recommended in the order listed:

(*a*) *Mill-run bran and sawdust.*

Mill-run bran, mixed feed, or shorts	25 pounds
Sawdust (three times bulk of mill-run bran)	3½ bushels
Sodium fluosilicate	4 pounds
Water	10 to 12 gallons

(*b*) *Standard bran and sawdust.*

Standard wheat bran	50 pounds
Sawdust (equal to bran in bulk)	2¼ bushels
Sodium fluosilicate	4 pounds
Water	10 to 12 gallons

Note. The mill feeds recommended in these formulas contain considerable quantities of flourlike material mixed with flakes of wheat bran. When moistened by the water, the sawdust particles are coated with a paste formed by the finer materials. Grasshoppers gnaw and chew the sawdust to obtain the flour paste and are killed by the poison (sodium fluosilicate) it contains. If sodium fluosilicate is not available, liquid sodium arsenite (32 percent arsenious oxide) may be substituted at the rate of ½ gallon liquid arsenite for each 4 pounds of fluosilicate. The arsenite is added to the water used to moisten the bait. Liquid arsenite increases the accidental poisoning hazard.

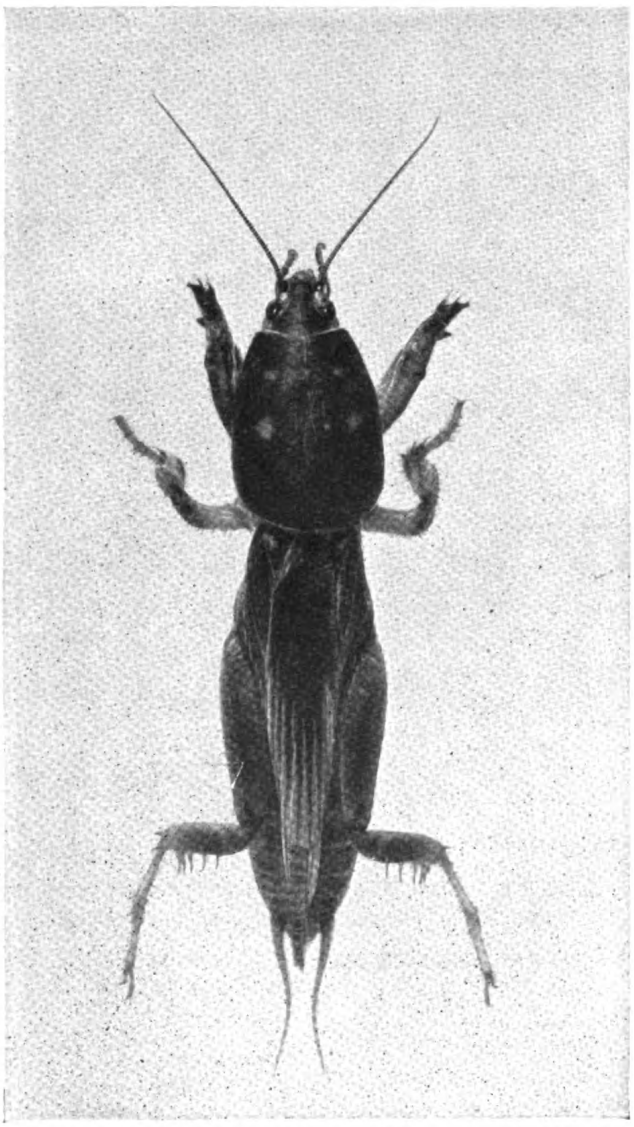
(2) *Procedure.* Mix baits by hand on a tight floor or in a suitable box. (See fig. 96.) Spread required amount evenly over floor about 6 inches deep. Mill feed is spread over the sawdust and sodium fluosilicate scattered evenly over bran. Thoroughly mix these dry ingredients by turning with shovels. Add water in two or three applications, and turn mixture with shovels to insure that

Figure 96. Control of grasshoppers, cutworms, and mole crickets with bran-sodium fluosilicate bait.

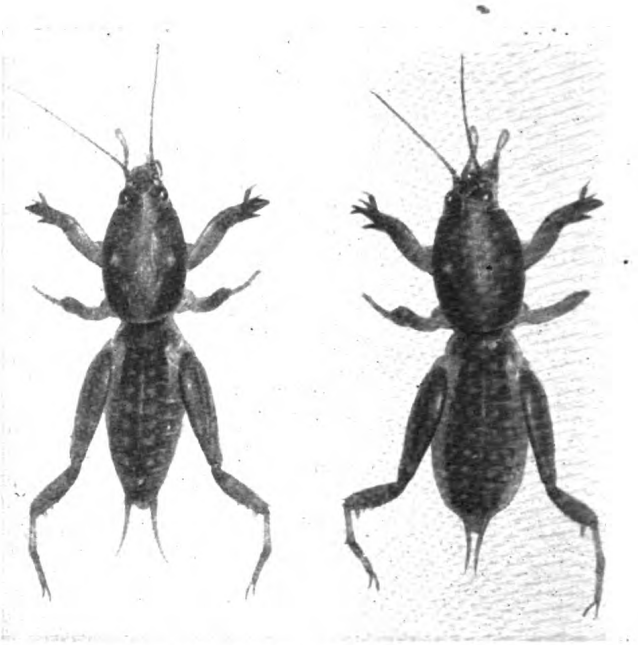
all saw dust particles become coated with poison. Make prepared poison bait just moist enough to ball up when squeezed in the hand. Broadcast bait evenly over infested fields at rate of 10 to 15 pounds of wet bait to an acre for each application. Repeat treatment as necessary. For best results, make even distribution.

70. Mole Crickets

a. General. Mole crickets may seriously damage grassed areas on Army reservations from North Carolina to Texas, principally in the Fourth and Eighth Service Commands. (See fig. 97.) Although mole crickets and common field crickets belong to the same family, they bear only a slight resemblance. The most striking characteristics of mole crickets are large, beady eyes and short, stout front legs which bear shovellike digging feet. They live and burrow in the upper 2 inches of sandy soil, uprooting or killing many plants. When mole crickets become established in grassed areas, much damage is caused if control measures are not applied. For house-cricket control, see chapter 12.



① *Adult mole cricket.*



② *Nymph or young of the mole cricket.*

Figure 97.—Continued.

b. Poisoned Bait. Mole crickets feed at night near the soil surface, and they can be controlled effectively by poisoned bait. The most desirable time for baiting is during August and September when the immature forms are developing and require much food.

(1) *Formula.* The recommended poison bait has the following formula:

Wheat bran	100 pounds
Sodium fluosilicate	8 pounds
Water to moisten	3 to 5 gallons

(2) *Procedure.* Thoroughly mix sodium fluosilicate with bran, covering every particle of bran with the poison. Add enough water to the dry bran-poison mixture so it forms a ball of loose texture when squeezed by hand and breaks off into a crumbly mash when distributed. Since the moist bait tends to mold and spoil rapidly, mix it only as needed. Corn meal or wheat flour may be substituted for the wheat bran but are less satisfactory. In handling sodium fluosilicate and mixing the

Figure 97.

poison bait, take care not to inhale the dust. When mixing large amounts of bait, wear dust respirators that protect the entire face. Keep all unused bait or sodium fluosilicate under lock and key to prevent improper use.

(3) *Dosage.* A single application of poisoned bait is estimated to kill about three-fourths of the population in a given area. A second application and possibly others should be made at intervals of about 10 days. Bait needs are estimated on the basis of 20 pounds of dry bran for each acre to be baited.

71. Miscellaneous Insects

A number of insects, including cutworms, chinch bugs, and Army worms, damage the vegetative cover of Army reservations. Control of these insects may involve special problems and assistance of service command headquarters should be obtained for control recommendations.

CHAPTER 17
INSECTS DAMAGING TREES AND SHRUBS

72. General

Trees, shrubs, and other ornamentals at Army installations are valuable for good troop morale. They prevent excessive sunshine and heat, and retard erosion. A general knowledge of the common insect pests and their control is necessary for growing and maintaining healthy, attractive plantings. Various insects attacking plants may be divided into four general classes:

a. Chewing insects.
b. Sucking insects.
c. Gall-forming and leaf-mining insects.
d. Wood and bark borers.

73. Control Measures

a. Proper Cultivation. The variety of trees and shrubs selected and their subsequent cultivation have much to do with the extent of insect injury. Some practices in cultivation which help avoid the heavy expense of insect control on trees and shrubs are as follows:

(1) Select strong, vigorous, healthy trees and shrubs of varieties adapted to growth in the area planted.

(2) Plant those species of varieties that have greatest resistance to insect attack.

(3) Insure vigorous growth of trees and shrubs by proper cultivation, fertilization, and moisture.

(4) Remove weakened and devitalized trees because they are especially susceptible to insect attack and large numbers of insects may spread to healthy ones.

(5) Practice clean culture. Avoid leaving refuse, weeds, or piles of lumber around to provide favorable winter protection for injurious insects.

(6) When insect control becomes necessary, apply prompt and effective measures to minimize the extent of injury.

b. Selection of Insecticides. The method by which the particular insect feeds determines the type of insecticide used. Caterpillars, leaf beetles, and bagworms chew and swallow the leaves; they can be most readily controlled by such stomach poisons as arsenical sprays applied to the foliage. Insects which suck plant sap without consuming the surface of the leaf, however, must be controlled by a contact insecticide which covers the pests in sufficient amounts to destroy them. Fumigant gasses are rarely used to control tree, shrub, or ornamental insects at Army posts. Although tests with DDT indicate that it is effective, mixtures of this material should not be applied to trees and shrubs unless approved by service command headquarters.

74. Leaf-eating Insects

a. Caterpillars, leaf beetles, and other insects that chew the foliage are controlled by stomach poisons such as lead arsenate, a white powder sprayed on the plants at the rate of 1.5 to 2.5 pounds stirred into 50 gallons of water. The arsenical must be kept thoroughly mixed throughout the spraying process. Calcium arsenate and paris green, which are sometimes substituted for lead arsenate, burn the foliage of less resistant plant species. Power spraying and dusting equipment is used to control insect outbreaks on large trees or for large areas. For small applications made with knapsack type sprayers equipped with agricultural spray nozzles, 2 to 3 tablespoonfuls should be used with each gallon of water.

b. Because lead arsenate whitens vegetation, cryolite used either as a dust or a suspension in water may be substituted at the strength indicated on the package. Cryolite is no more injurious to foliage than lead arsenate and is less poisonous to larger animals.

c. Rotenone sprays and dusts serve both as a stomach and a contact poison; they have little toxic effect on man. Rotenone insecticides are very effective against certain insect species but have little effect on others. However, these dusts are convenient and economical for small-scale control of both chewing and sucking insects on

ornamental plants. Although effective, they are slow-acting and frequently do not show up well until 2 or 3 days after applications.

75. Sucking Insects

Contact sprays are most commonly used to kill tree and shrub-infesting insects having piercing mouth parts (plant lice (fig. 98), scale insects, leafhoppers, and plant bugs). The contact insecticides most commonly used are nicotine sulfate, petroleum oils, lime-sulfur, rotenone, pyrethrum, and soaps. Directions of the manufacturer should be followed in using commercial spray and dust preparations.

Figure 98. Aphids or plant lice.

a. Nicotine Sulfalte. Nicotine sulfate (40 percent nicotine content) mixed with dissolved soap destroys aphids (plant lice), immature stages of leafhoppers, and other types of soft-bodied sucking insects. Spray with one or more applications of a mixture of 1 pint of nicotine sulfate and 4 pounds of dissolved soap powder in 75 gallons of water. For small amounts, mix 1¼ teaspoonfuls of nicotine sulfate and 1 tablespoonful of soap powder in 1 gallon of water.

b. Petroleum Oils. Two types of petroleum oil sprays are commonly used in insect control, depending on whether the plants are in foliage or dormant. Highly refined oils may be used for summer application on plant foliage in emulsion up to a strength of 2 percent actual oil. Miscible summer oils are available and are less difficult to prepare than oils to which an emulsifier must be added. If nicotine sulfate is added at the rate of 1 pint to 100 gallons of diluted emulsion containing 1 percent oil, the spray is effective against aphids, immature leafhoppers, and the immature stages of scale insects. Dormant spray oils are not so highly refined but are more effective. They can be applied only during the late fall or early spring (in winter in areas with milder climates) when leaves have fallen from deciduous trees. If applied to foliage, dormant oils are likely to kill vegetation. Dormant oils applied as emulsions at 3 percent actual oil content are effective against scale insects and control certain mites to some extent. Dormant oils of the miscible type are the easiest to prepare because they are mixed directly with water.

c. Lime Sulfur. Used at a strength of 1 gallon commercial lime-sulfur concentrate to 8 gallons

of water during the dormant season, lime sulfur is effective for controlling scale insects and such spider mites as the red spider. (See fig. 99.)

d. Sulfur. Finely ground sulfur (300–325 mesh) dusted on affected plants is used for controlling red spiders. If a spray is desired, add 1 pound of wettable sulfur to 3 gallons of water,

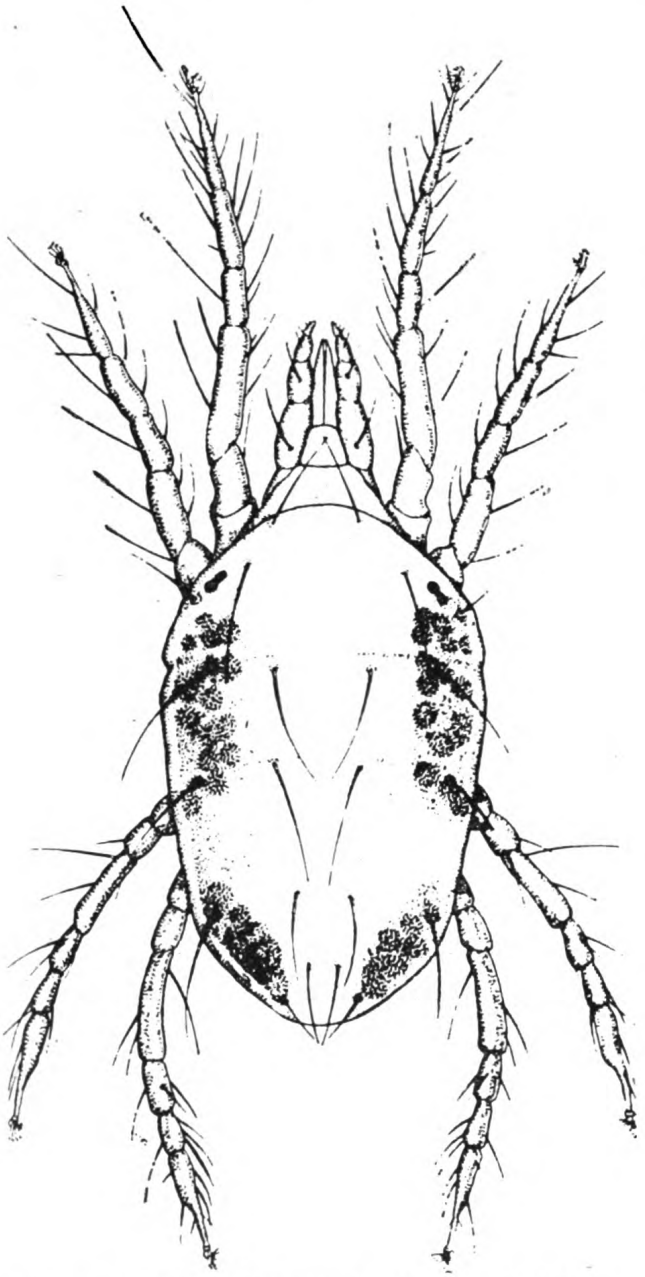


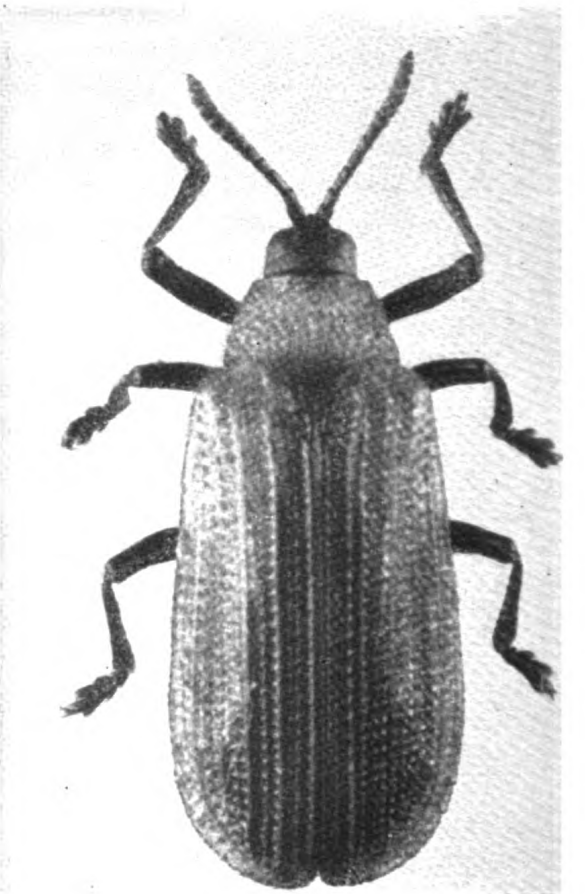
Figure 99. Red spiders, a mite that attacks foliage.

keeping the material thoroughly mixed during application.

e. Pyrethrum and Rotenone. Contact sprays and dusts made from pyrethrum and rotenone materials are effective against certain sucking insects which infest shrubs and trees. During wartime, the supply of these insecticides may be critical, and their general use is not recommended. Because the various commercial preparations containing pyrethrum or rotenone differ considerably in strength, manufacturers' recommendations must be followed. These materials are not dangerous to man and domestic animals.

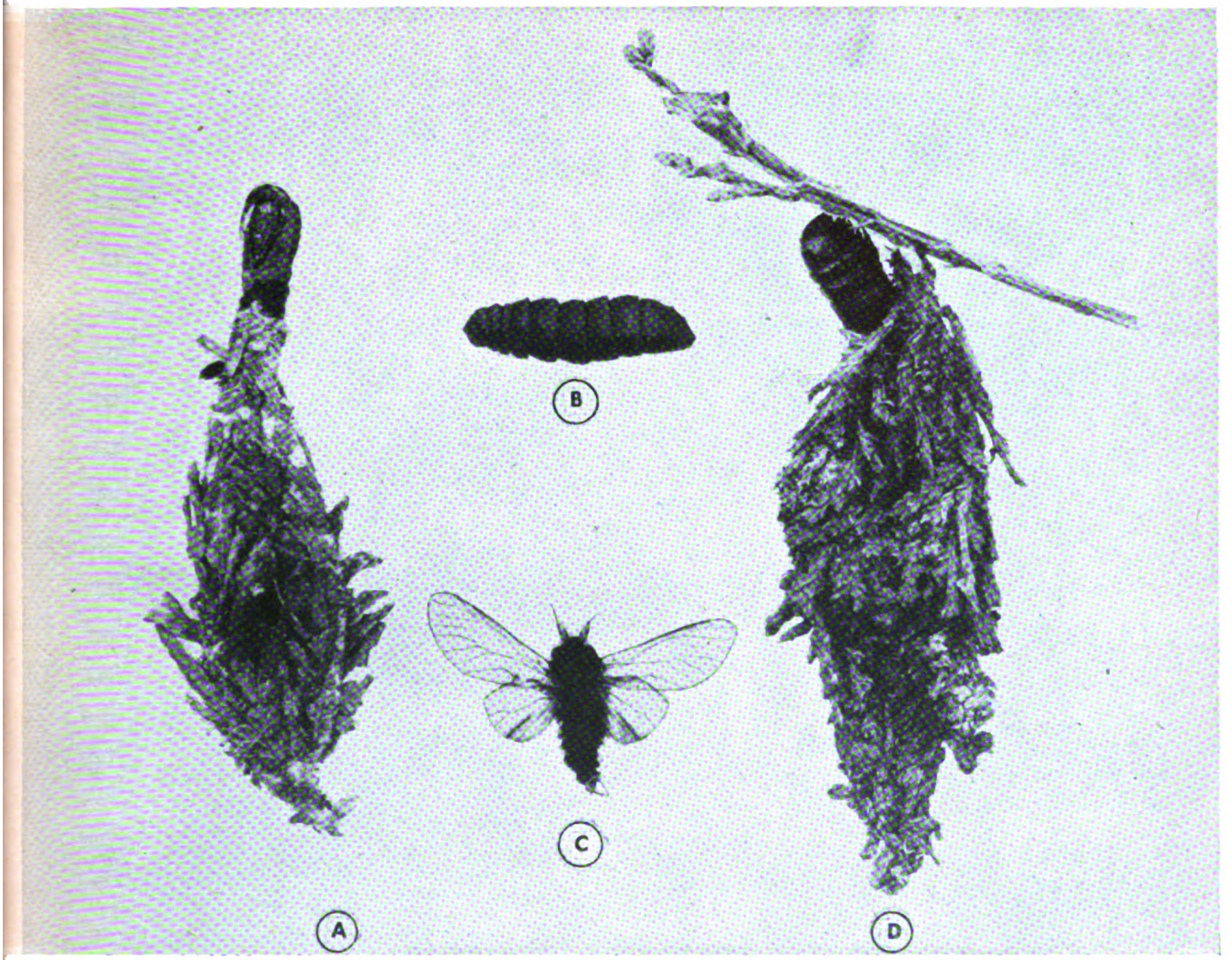
76. Wood and Bark Borers

Injection of chemicals into the sap stream of trees to destroy woodboring insects and bark beetles is not successful because chemicals which destroy the insects also damage or kill the trees and shrubs. Many pests which feed in the bark and wood prefer to attack weak, devitalized trees. (See figs. 100 and 101.) Good cultural practices, fertilization, keeping the soil from being packed down around trees, proper water and air relationship for the



① *Locust-leaf miner.*

Figure 100.



② *Bagworm moth; A, protective bag; B, pupa; C, adult moth; D, larva feeding.*

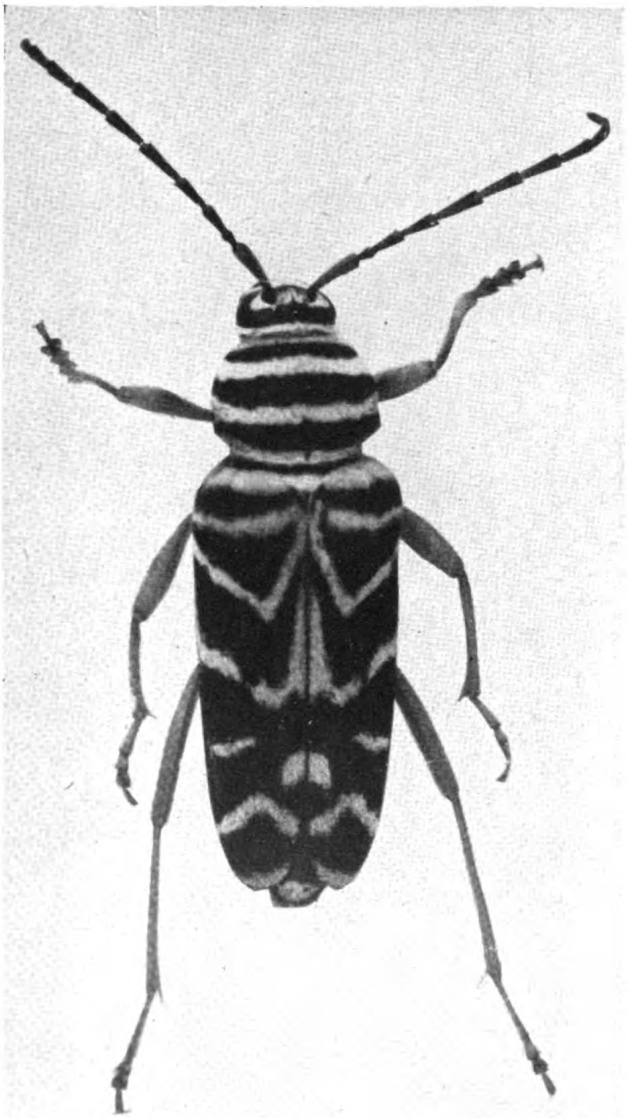
Figure 100—Continued.

root systems, and adequate sunlight favor vigorous plant growth and lessen borer injury.

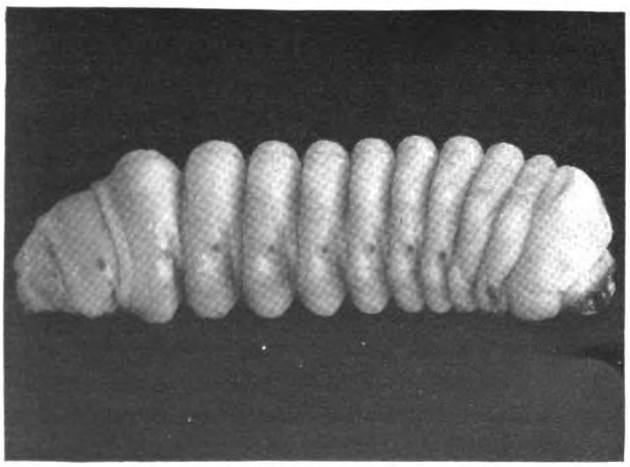
a. Lyctus Beetles (figs. 102, 103, and 104). Lyctus beetles (powder post beetles) damage buildings, stored-wood products, hardwood lumber, and finished hardwood products of such woods as oak, walnut, pecan, and hickory. Storage stock of such items as gun stocks, implement handles, wooden wheels, furniture, filing cabinets, and floors may be damaged. Control of these insects includes careful selection and grading of stock, frequent inspection, and chemical treatments. Recommendations are obtained from service command headquarters for chemical treatments. Repellent treatments available for protecting rough and green lumber as well as seasoned wood products include use of borax, sulfur, pentachlorophenol, and linseed oil. Treatments involve use of suitable apparatus for handling lumber and finished wood products and provide protection for about 1 to 2 years. Manufactured articles such as furniture and floors of buildings are often most economically treated by surface applications of chemicals. Effective penetrating toxic substances include orthodichlorobenzene, turpentine, kerosene, and light pine oils.

b. Wood Borers. Where openings to the tunnels of tree borers can be located, carbon disulfide may be injected into the burrow with an eye dropper. Putty is used to seal the holes after this fumigant is introduced. (See fig. 105.)

(1) *Repellent washes.* For trees severely attacked by wood borers, repellent washes may be applied during May or June when the borers commence laying eggs. An effective wash consists of 1 gallon of soap dissolved in hot water, into which



① *Adult locust borer.*



② *Larva of locust borer.*

Figure 101.

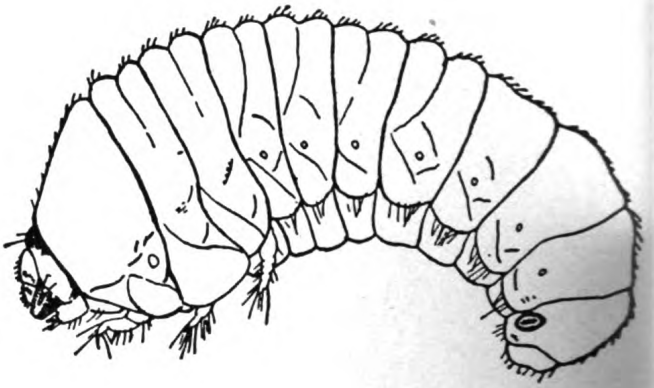


Figure 102. Adult and larva of lyctus beetle (powder post).

Figure 103. Lyctus beetle damage to ax and pick handles.

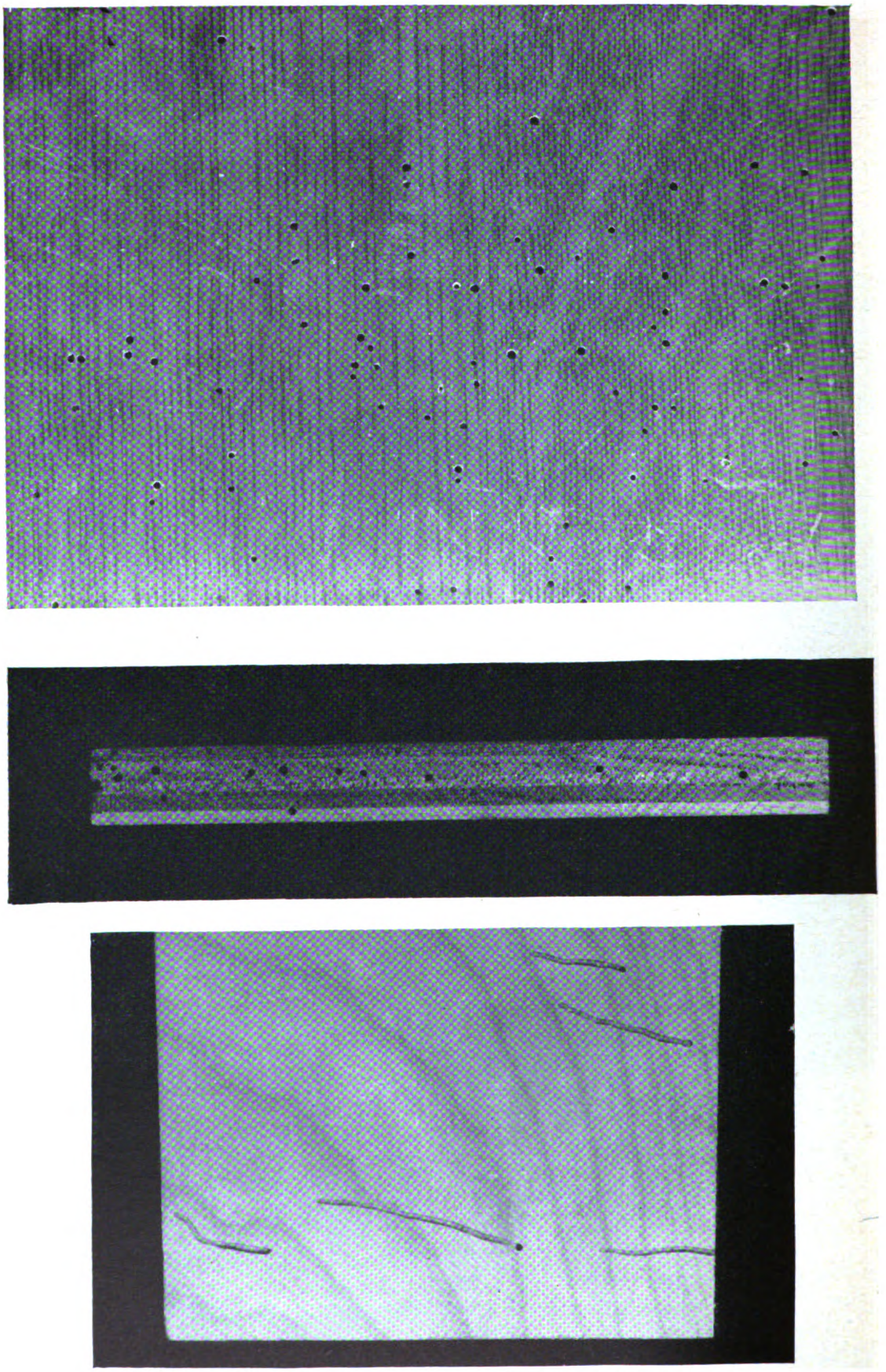
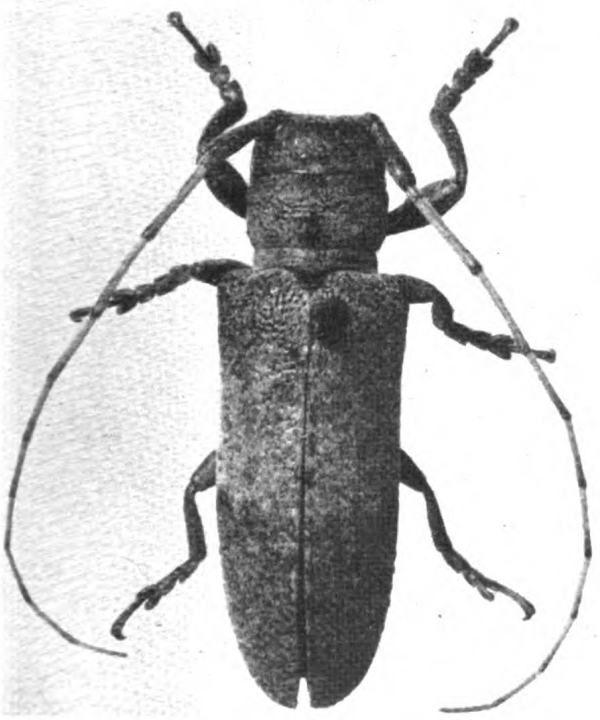


Figure 104. Lyctus beetle damage to veneered plywood.

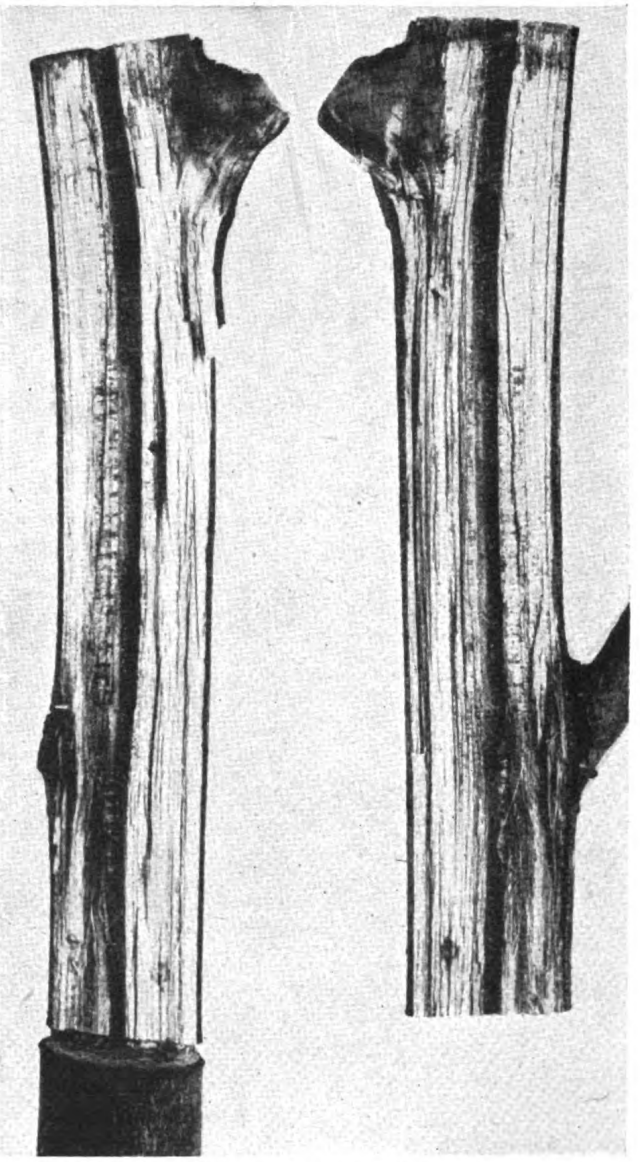
1 pint of crude carbolic acid is stirred thoroughly. Allow the wash to stand overnight and dilute it with 8 gallons of water. Apply it to tree trunks and larger limbs with a paint brush. Repeat treatment three times at 1-week intervals.

(2) *Protectors.* Protectors made of newspapers, building paper, or other heavy paper wrapped around the trunks of trees, especially trees newly planted, protect against trunk-boring insects. Cylindrical protectors of fine-mesh wire, surrounding the trunks of trees but with adequate clearance and with the top stuffed with cotton to prevent insect entry, protect valuable tree plantings under some conditions.

c. Bark Beetles (fig. 106). A pine oil preparation is useful in controlling bark beetles and borers. Dissolve 1 pound of paradichlorobenzene in 1 quart of miscible pine oil. When ready to use, mix solution with 2 quarts of water and paint the infested bark.

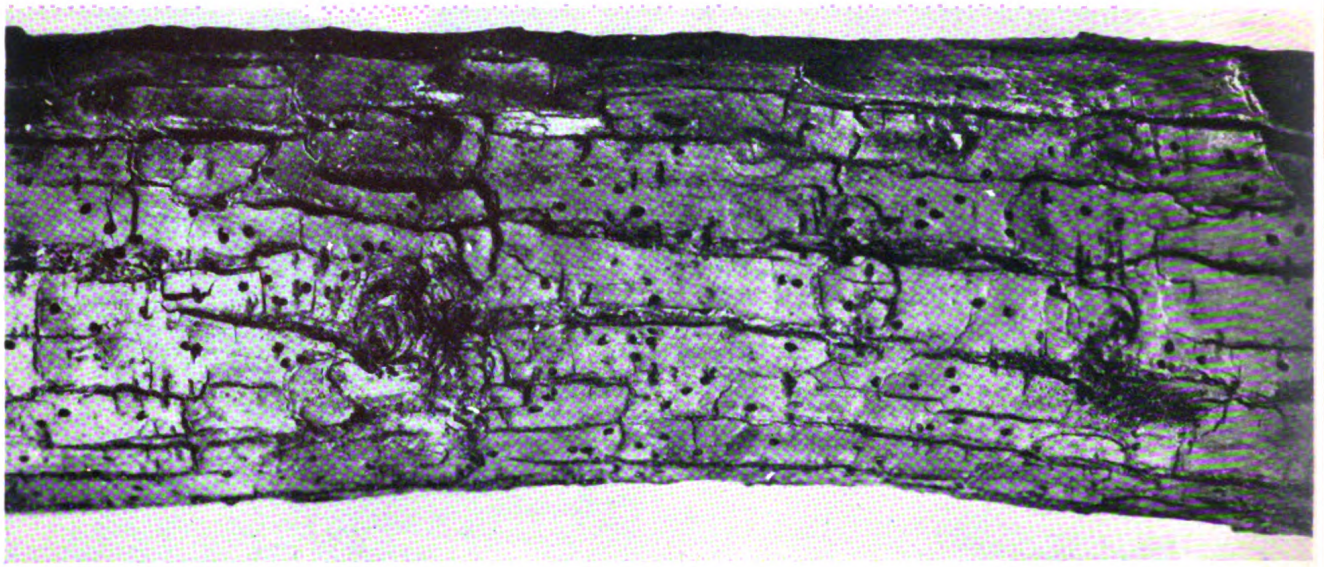


① *The twig girdler.*

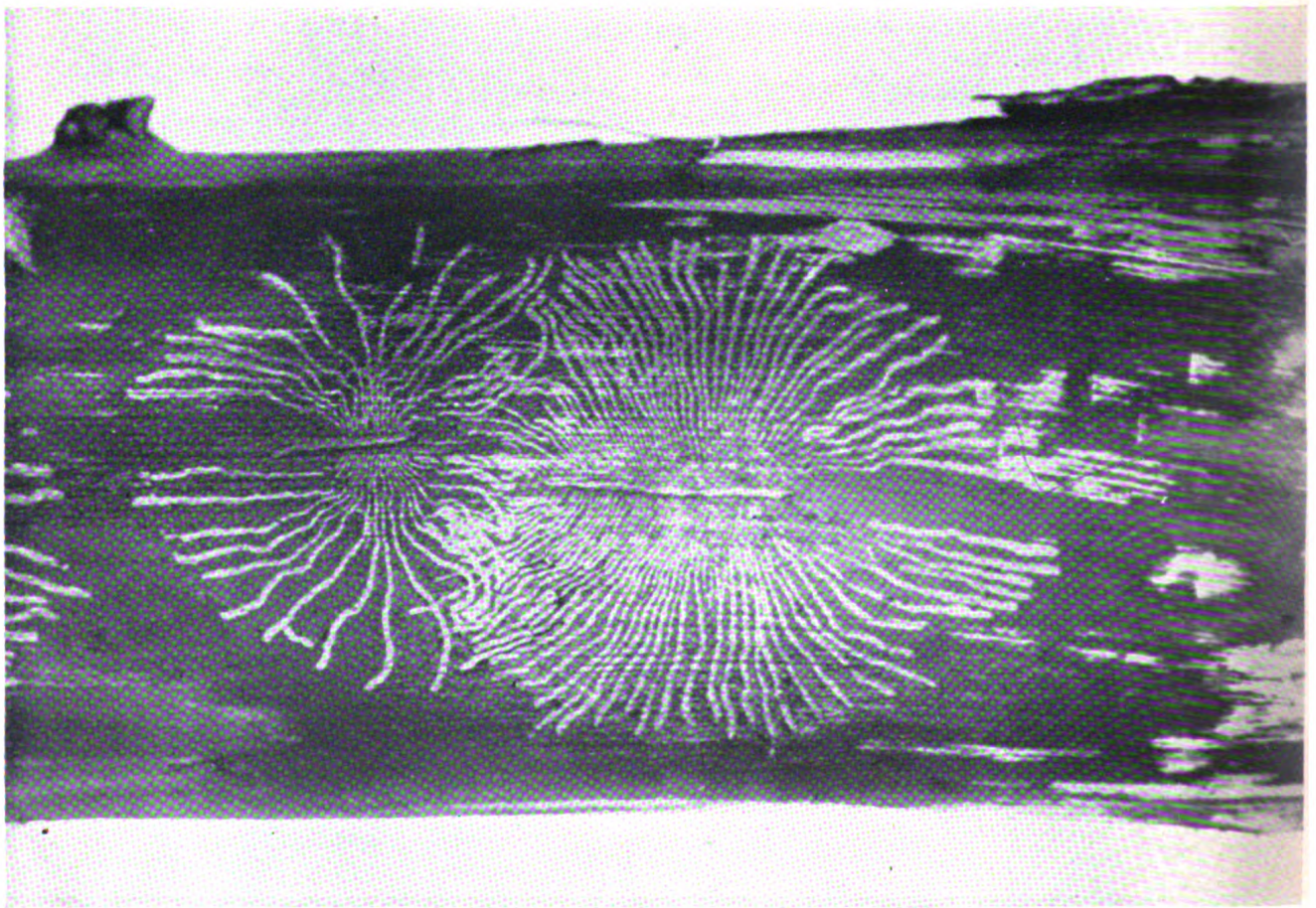


② *Damage by twig girdler.*

Figure 105.



① *European elm bark beetle, showing exit holes.*



② *Egg galleries and larval mines of the European elm bark beetle.*

Figure 106.

CHAPTER 18
SUPPLIES

77. General

Quartermaster items are obtained from the post supply officer in the quantities listed in the Table of Allowances. Quantities of engineer items needed for insect and rodent control are determined by the post engineer, who should forward requisitions to service command headquarters for approval. Sources of supply include manufacturers of chemicals, finished insecticides, and spraying and dusting apparatus. Some items may be procured locally from seed or general agricultural supply stores. Information regarding sources of supply may be obtained from service command headquarters.

78. Quartermaster Corps

Insecticides and items of equipment for insect and rodent control are authorized for supply to the service commands of continental United States in accordance with allowances prescribed below:

Insect and rodent control items for service commands of United States

Item	Basis of issue
51–B–699–BORAX, powdered, 1- to 10-pound package. (Until present supplies are exhausted.)	(See WD Cir. 163, 1945, for basis of issue.)
41–D–3755–DUSTER, powder, insecticide.	
42–F–8650–FLY SWATTERS	
51–I–159–INSECTICIDE, Aerosol, 1-pound dispenser.	
51–I–305–INSECTICIDE, spray DDT, residual effect.	
51–I–169–INSECTICIDE, liquid, finished spray.	
51–I–173–INSECTICIDE, powder, louse, 2-ounce can.	
51–I–180–INSECTICIDE, powder, louse.	
51–I–210–INSECTICIDE, powder, roach, 5-pound package. (Will be issued until present supply is exhausted.)	

Insect and rodent control items for service commands of United States—Continued

Item	Basis of issue
51–I–310–INSECTICIDE, spray, delousing.	
51–L–120–LARVICIDE, DDT, powder, dissolving.	
51–L–122–LARVICIDE, DDT, powder, dusting.	
51–M–888–METHYL BROMIDE 20 cubic centimeter ampoule.	
51–M–892–METHYL BROMIDE, 1-pound cans.	
42–P–1997–PAPER, fly, ribbons, 100 to box. (Will be issued until present supply is exhausted.)	
51–R–265–REPELLENT, insect (2-ounce bottle).	
41–S–4106–SPRAYER, liquid, insect, continuous spray.	
42–T–12900–TRAP, rat, spring type.	
42–T–12500–TRAPS, mouse, spring type.	
7–O–164–55–OIL, fuel, (for oil burners) Grade FS2 (55-gallon drums).	
51–R–465–RODENTICIDE, general control, 1-pound package.	
51–R–470–RODENTICIDE, plague control, 1½-pound jar.	
51–R–460–RODENTICIDE, fumigant dust.	
41–2975–PUMP, foot, rodenticide fumigant.	

79. Corps of Engineers

The items for insect and rodent control supplied by the Corps of Engineers include paris green, egg albumin, hydrocyanic acid gas (HCN) discoids or fumigants, dusters, and sprayers. Allowances on these items have not been set up for the continental United States. Determination of the necessary quantities for posts is the function of the post engineer and the unit engineer, subject to approval of the responsible commanding officer. OCE is responsible for procurement and supply of these items. Some Corps of Engineer items are listed as follows:

Item	Specifications	Requirements	Funds	Purchase	Inspection	Storage and issue
Egg albumen	QMC	Eng	Eng	Eng	Eng	Eng
HCN discoids	QMC	Eng	Eng	Eng	Eng	Eng
Paris green	QMC	Eng	Eng	Eng	Eng	Eng
Sprayer, knapsack (C of E Stock No. 41–7839.400.030).	Eng	Eng	Eng	Eng	Eng	Eng
Sprayer, power (C of E Stock No. 40–9030.6–3)	Eng	Eng	Eng	Eng	Eng	Eng
Duster, hand, rotary blower type (C of E stock No. 41–3115.5–10).	Eng	Eng	Eng	Eng	Eng	Eng

Note. In addition to the above list, the Corps of Engineers also procures, purchases, stores, and issues special materials and equipment needed and used for pest control. Items for which local procurement may be necessary include insecticides, fungicides, solvents, wetting agents, sprayers, dusters, fumigation chambers, dust mixers, and other materials recommended for use by post engineers.

CHAPTER 19

PRECAUTIONS FOR USE OF MATERIALS AND EQUIPMENT

80. Mixing and Applying Materials

a. Take necessary precautions when mixing, applying, or handling insecticides and rodenticides.

b. Keep materials out of mouth and eyes and away from skin.

c. Wash face and hands with soap and water after handling chemicals.

d. Change clothes twice a day if necessary to keep chemicals from skin. Bathe with each change of clothing.

e. Do not allow residues of sprays and dusts to accumulate in clothing.

81. DDT Sprays and Dusts

DDT is a toxic material and safety precautions must be observed in connection with its use. The inhalation of dusts or mists containing DDT should be avoided. Solutions of DDT in oils and organic solvents can be absorbed through the skin and should be handled with care to prevent contamination of skin and clothing. Approved gloves, respirators, and coveralls should be worn by crews for dusting and spraying work. Garments that become saturated with DDT in solution should be changed immediately and the operator should wash the affected parts of the body thoroughly with soap and water. Contamination of food with DDT must be prevented. Storage of DDT dusts or sprays with food should be strictly prohibited to prevent mistakes in identity.

When DDT in kerosene or kerosene-methylated naphthalene solutions is applied as a residual spray by properly trained personnel, it may be assumed that no explosion hazard exists unless open flames or temperatures exceeding 100° F. are present. All recommended fire prevention practices should be observed. The use of DDT emulsions or solutions with solvents other than kerosene should be cleared with service command headquarters for recommendations on fire prevention.

82. Protective Devices

Suitable goggles, respirators, gloves, and coveralls should be worn by operators exposed to insecticides, fungicides, and rodenticides. This is true especially with indoor spraying and dusting of DDT.

a. Use respirators of the mechanical-filter type, approved by the United States Bureau of Mines and manufactured by several companies. Protection should be given against metallic and mineral dust, nuisance dust, and mists produced in spraying operations.

b. Use gloves made of tough fabric with synthetic coating resistant to oils, greases, petroleum solvents, acids, corrosive chemicals, and abrasions. Rubber latex gloves are also satisfactory but more difficult to procure.

c. Obtain *colored* dusting powders such as sodium fluoride, lead arsenate, and calcium arsenate. These dusts are colored by the manufacturer. DDT dusts of present manufacture are not colored.

d. When applying fumigants, provide gas masks with a canister that protects the operator from breathing the poisonous fumes.

83. Storage

Post engineers should maintain stock rooms of insecticides, rodenticides, and fumigants in sufficient quantity to meet normal requirements of the post for 60 to 90 days. The materials should be kept under lock and key to prevent wastage and improper use.

84. Care of Apparatus

Spraying and dusting equipment and apparatus for the application of fumigants must receive proper care to insure a satisfactory performance.

a. Keep all equipment clean and stored in a dry stock room.

b. At the end of each day's use, remove unused portions of sprays and dusts from spray pumps, hose, tanks, dust guns, and valves.

c. Clean out residues of solutions or emulsions by rinsing thoroughly with clear water.

d. Apply oil or grease to unpainted metal parts subject to rusting.

e. Lubricate working parts properly.

85. First Aid Suggestions

Accidents may occur when poisonous substances are handled.

a. The post surgeon should be notified of an accident immediately.

b. The victim is given first aid on the spot by the medical officer of the day and removed to the hospital as soon as possible.

c. Pest-control foremen should never give liquids to a victim who is unconscious but should keep him lying down until the medical officer arrives.

d. If he is unconscious and cold, body warmth should be protected by wrapping the victim in a blanket or other covering. Hot objects should not be applied.

e. Artificial respiration should be used if breathing has stopped. This method of resuscitation must be used by one properly trained to apply it.

APPENDIX I

ACKNOWLEDGMENTS

The U. S. Navy, the U. S. Public Health Service, the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, the Fish and Wild Life Service of the U. S. Department of the Interior, and the Signal Corps, U. S. Army, have cooperated with the Corps of Engineers by furnishing some of the photographic material appearing in this manual.

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APPENDIX III

LIST OF INSECTS AND RODENTS

The following is a list of the common and scientific names of the more important insects and rodents included in this manual.

Chapter	*Common name*	*Scientific name*
2. Mosquitoes	Anopheline mosquitoes	*Anopheles* spp
	Culicine mosquitoes	*Aedes* spp
		Culex spp
		Psorophora spp
		Mansonia spp
3. Flies	Housefly	*Musca domestica*
	Green bottle flies	*Lucilia* spp
	Bluebottle flies	*Calliphora* spp
	Deerflies	*Chrysops* spp
	Stable or dogfly	*Stomoxys calcitrans*
4. Gnats	Sandflies	*Phlebotomus* spp
	Punkies or sandflies	*Culicoides* spp
	Blackflies	*Simulium* spp
	Eye gnats	*Hippelates* spp
5. Bugs	Bedbug	*Cimex lectularius*
	Tropical bedbug	*Cimex hemipterus*
	Bloodsucking conenose	*Triatoma sanguisuga*
6. Lice	Body louse	*Pediculus humanus corporis*
	Head louse	*Pediculus humanus humanus*
	Crab louse	*Phthirus pubis*
7. Fleas	Human flea	*Pulex irritans*
	Dog flea	*Ctenocephalides canis*
	Cat flea	*Ctenocephalides felis*
	Oriental rat flea	*Xenopsylla cheopis*
	Chigoe	*Tunga penetrans*
8. Ticks	Rocky Mountain spotted fever tick or wood tick.	*Dermacentor andersoni*
	Pacific Coast tick	*Dermacentor occidentalis*
	American dog tick	*Dermacentor variabilis*
	Relapsing fever tick	*Ornithodorus turicata*
9. Chiggers	Chigger	*Entrombicula alfreddugesi*
10. Termites	Subterranean termites	*Reticulitermes* spp
	Dry wood termites	*Kalotermes* spp
11. Rodents	Norway rat	*Rattus norvegicus*
	Black rat	*Rattus rattus rattus*
	Roof rat	*Rattus rattus alexandrinus*
	House mice	*Mus* spp
	Meadow mice	*Microtus* spp
	Ground squirrels	*Citellus* spp

Chapter	Common name	Scientific name
12. Cockroaches	German cockroach	*Blattela germanica*
	American cockroach	*Periplaneta americana*
	Oriental cockroach	*Blatta orientalis*
	Australian cockroach	*Periplaneta australasiae*
	Brown banded roach	*Supella supellectilium*
13. Ants	Argentine ant	*Iridomyrmex humilis*
	Red harvester ant	*Pogonomyrmex barbatus*
	Carpenter ants	*Camponotus* spp
	Odorous house ant	*Tapinoma sessile*
	Pavement ant	*Tetramorium caespitum*
	Pharaoh ant	*Monomorium pharaonis*
14. Stored-product insects	Black carpet beetle	*Attagenus piceus*
	Cadelle	*Tenebroides mauritanicus*
	Confused flour beetle	*Tribolium confusum*
	Red flour beetle	*Tribolium ferrugineum*
	Saw-toothed grain beetle	*Oryzaephilus surinamensis*
	Indian meal moth	*Plodia interpunctella*
	Mediterranean flour moth	*Ephestia kuehniella*
	Casemaking clothes moth	*Tinea pellionella*
	Webbing clothes moth	*Tineola bisselliella*
	Silverfish	*Lepisma saccharina*
	Broadbean weevil	*Bruchus ruftimanus*
	Pea weevil	*Bruchus pisorum*
	Rice weevil	*Sitophilus oryza*
	Larder beetle	*Dermestes lardarius*
	Hide beetle	*Dermestes maculatus*
	Red-legged ham beetle	*Necrobia rufipes*
	Cabinet beetles	*Trogoderma* spp
	Cheese skipper	*Piophila casei*
16. Insects Attacking Grassed Areas.	Japanese beetle	*Popillia japonica*
	Green June beetle	*Cotinus nitida*
	Carolina grasshopper	*Dissosteira carolina*
	Differential grasshopper	*Melanoplus differentialis*
	Red-legged grasshopper	*Melanoplus femur-rubrum*
	Long-winged grasshopper	*Dissosteira longipennis*
	Southern mole cricket	*Scapteriscus acletus*
	Army worm	*Cirphis unipuncta*
17. Insects Damaging Trees and Shrubs.	Plant lice	*Aphis* spp
	Red spider	*Tetranychus* spp
	Locust borer	*Cyllene robiniae*
	Powder post beetle	*Lyctus planicollis*
	Twig borers	*Saperda* spp
	Twig girdlers	*Oncideres* spp
	Elm bark beetles	*Scolytus* spp

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U. S. GOVERNMENT PRINTING OFFICE: 1945

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 45 cents